ORAL ARGUMENT NOT YET SCHEDULED

No. 20-1026

IN THE UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT

FRIENDS OF THE EARTH, NATURAL RESOURCES DEFENSE COUNCIL, INC., AND MIAMI WATERKEEPER,
Petitioners,

v.

UNITED STATES NUCLEAR REGULATORY COMMISSION AND UNITED STATES OF AMERICA,
Respondents.

Petition for Review of a Final Order of the
United States Nuclear Regulatory Commission

DEFERRED JOINT APPENDIX
VOLUME 1 of 4

JA00001 TO JA00346

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October 30, 2020

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SUBSEQUENT LICENSE RENEWAL APPLICATION FOR

TURKEY POINT NUCLEAR GENERATING UNIT NOS. 3 AND 4

BACKGROUND

The U.S. Nuclear Regulatory Commission (NRC) received an application dated January 30, 2018 (Agencywide Documents Access and Management System (ADAMS) Package Accession No. ML18037A812), from Florida Power & Light Company (FPL), filed pursuant to Section 103 of the Atomic Energy Act of 1954, as amended, Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, “Environmental Protection Regulations For Domestic Licensing And Related Regulatory Functions,” and 10 CFR Part 54, “Requirements for Renewal of Operating Licenses for Nuclear Power Plants,” for subsequent license renewal of the renewed operating licenses for Turkey Point Nuclear Generating Unit Nos. 3 and 4 (Turkey Point or Turkey Point Units 3 and 4). FPL subsequently supplemented its application by letters dated February 9, 2018 (ADAMS Accession No. ML18044A653), February 16, 2018 (ADAMS Package Accession No. ML18053A123), March 1, 2018 (ADAMS Package Accession No. ML18072A224), and April 10, 2018 (ADAMS Package Accession Nos. ML18102A521 and ML18113A132).

The Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.) (AEA), specifies that licenses for commercial power reactors can be granted for an initial period of up to 40 years. NRC regulations permit these licenses to be renewed beyond the initial 40-year term for an additional period of time, limited to 20-year increments per renewal, based on the results of an assessment to determine whether the nuclear facility can continue to operate safely during the proposed period of extended operation. There are no limitations in the AEA or NRC regulations restricting the number of times a license may be renewed.

The NRC granted initial renewed licenses to FPL for Turkey Point Units 3 and 4 on June 6, 2002. The Turkey Point Unit 3 current renewed facility operating license (DPR-31) and the Turkey Point Unit 4 current renewed facility operating license (DPR-41) expire on July 19, 2032, and April 10, 2033, respectively. The subsequent renewed operating licenses would authorize FPL to operate Turkey Point Units 3 and 4 until July 19, 2052, and April 10, 2053, respectively.

Turkey Point Units 3 and 4 are Westinghouse pressurized-water nuclear reactors located on approximately 9,460 acres (ac) (38.3 square kilometers (km^2)) of FPL-owned land. Each reactor is designed to produce a core thermal power output of 2,644 megawatts-thermal (MWt) with a corresponding gross electrical output of approximately 811 megawatts-electric (MWe) for Unit 3 and 821 MWe for Unit 4. The Turkey Point site is located on the southeastern coast of Florida in unincorporated southeastern Miami-Dade County. The site borders Biscayne Bay and Card Sound to the east, and is adjacent to Biscayne National Park.

In addition to nuclear generating Units 3 and 4, the Turkey Point site also hosts three fossil fuel power plants: Units 1 and 2 are retired natural-gas/oil steam-generating units, and Unit 5 is an operating natural-gas combined-cycle steam generating unit. In addition to these five currently operating and retired units, the NRC has previously issued combined licenses (COLs) to FPL, authorizing the construction and operation of two new nuclear plants (Turkey Point Units 6 and 7); those plants have not yet been constructed. The Turkey Point site also features a 5,900-ac (24 km^2) artificial body of water called the cooling canal system (CCS) that is used by Units 3 and 4 for reactor heat rejection, as well as by Units 1 and 2 for operation in synchronous condenser mode and by Unit 5 for the discharge of blowdown. The yet to be constructed nuclear reactors (Units 6 and 7) will not use the CCS.

On April 18, 2018, the NRC staff published a notice of receipt of the subsequent license renewal application in the *Federal Register* (FR) (83 FR 17196). On May 2, 2018, the NRC staff published a notice that it had accepted the application for review and provided notice of an opportunity to request a hearing or petition to intervene (83 FR 19304). As discussed below, an adjudicatory proceeding concerning the application was then conducted.

Section 102 of the National Environmental Policy Act of 1969, as amended (NEPA), directs Federal agencies to prepare a detailed statement in advance of making a decision on major Federal actions that may significantly affect the quality of the human environment. In accordance with the Commission's regulations in 10 CFR Part 51, the NRC prepares an environmental impact statement (EIS) or a site-specific supplement to an EIS (SEIS) for all applications to renew reactor operating licenses pursuant to 10 CFR 51.20(b)(2), regardless of the action's environmental impact significance. In this instance, the NRC's major Federal action is to decide whether to issue subsequent renewed operating licenses for Turkey Point Units 3 and 4, authorizing operation for an additional 20 years through July 19, 2052, and April 10, 2053, respectively.

On May 22, 2018, the NRC staff published a notice of intent to prepare a supplemental environmental impact statement and conduct an environmental scoping process in the Federal Register (83 FR 23726). In addition, Federal, State, and local agencies, as well as Tribal governments, were notified and asked to provide comments on and to participate in the environmental scoping process and review. On May 31, 2018, the NRC staff held public scoping meetings near the Turkey Point site in Homestead, FL, to obtain public input on the proper scope of the NRC's environmental review of the Turkey Point Units 3 and 4 subsequent license renewal application. The NRC issued a scoping summary report on January 31, 2019 (ADAMS Accession No. ML18342A014).

The National Park Service, Southeast Region (NPS) participated in the environmental review as a cooperating agency under a Memorandum of Understanding with the NRC (ADAMS Accession No. ML18355A847). The NPS provided special expertise for the areas in and around the adjacent Biscayne National Park; however, impact determinations made in the EIS should not be attributed to NPS, but only to the NRC. The NPS's participation in connection with the EIS does not imply NPS concurrence with the NRC staff's impact determinations.

ENVIRONMENTAL IMPACT STATEMENT

In accordance with 10 CFR 51.95(c), "Operating License Renewal Stage," the NRC staff documents its environmental review of a license renewal application and publishes it as a site-specific supplemental environmental impact statement (called a SEIS), as a supplement to NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (called the GEIS) (ADAMS Accession Nos. ML13106A241, ML13106A242, and ML13106A244). The GEIS documents the results of the NRC's systematic approach to evaluating the environmental consequences of issuing renewed operating licenses for nuclear power plants authorizing an additional 20 years of operation beyond the end of the current license term. The GEIS serves to facilitate the NRC's environmental review process for license renewal by identifying and evaluating environmental impacts that are considered generic and common to all (or a distinct class of) nuclear power plants (Category 1 issues). For Category 1 issues, no additional site-specific analysis is required in the site-specific SEIS unless new and significant information is identified that would change the conclusions in the GEIS. The GEIS also identifies site-specific issues (Category 2 issues). For Category 2 issues, an additional site-specific review is required, and the NRC staff documents the results of that review in the SEIS.

The NRC established a standard of significance for each NEPA issue evaluated in the GEIS based on the Council on Environmental Quality's (CEQ) regulations on how to evaluate significance (see Title 40, "Protection of Environment," of the *Code of Federal Regulations* (40 CFR) 1508.27, "Significantly"). The term "significantly," as explained by the CEQ, requires consideration of both of the following:

1) Context—as in the geographic, biophysical, and social context in which the effects will occur.

2) Intensity—which refers to the severity of the impact in whatever context it occurs.

Since the significance and severity of an impact can vary with the setting of the proposed action, the NRC considered both "context" and "intensity" as defined in Council on Environmental Quality regulations at 40 CFR 1508.27. Context is the geographic, biophysical, and social context in which the effects will occur. In the case of license renewal, the context is the environment surrounding the nuclear power plant. As stated above, intensity refers to the severity of the impact in whatever context it occurs. Based on this, the NRC established a three-level standard of significance for potential impacts, SMALL, MODERATE, and LARGE, as defined below.

SMALL: Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

MODERATE: Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

LARGE: Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

FPL submitted its license renewal application and environmental report under the NRC's 2013 revised rule governing license renewal environmental reviews, as codified in 10 CFR Part 51.[1] The 2013 GEIS[2] provided the technical bases for the list of NEPA issues and associated environmental impact findings for license renewal that are contained in Table B–1, "Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants," in Appendix B to subpart A of 10 CFR Part 51.

The NRC's environmental review included an environmental scoping process. The scoping process included two public meetings held in Homestead, FL, on May 31, 2018. On March 31, 2019, the NRC staff issued a draft SEIS as "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 5, Second Renewal, Regarding Subsequent License Renewal for Turkey Point Nuclear Generating Unit Nos. 3 and 4, Draft Report for Comment," NUREG-1437, Supplement 5, Second Renewal (ADAMS Accession No. ML19078A330).

A 45-day comment period began on April 5, 2019, when the U.S. Environmental Protection Agency (EPA) published a Notice of Availability in the *Federal Register* (84 FR 13662) of the draft SEIS to allow members of the public, interested organizations and stakeholders, and governmental agencies to comment on the results of the staff's environmental review. The comment period ended on May 20, 2019. Additionally, the NRC held two public meetings on May 1, 2019, to discuss the preliminary findings in the draft SEIS.

Among other concerns, the continued operation of the cooling canal system and its potential impact on certain environmental resources was the focus of considerable concern expressed by members of the public and government agencies. The draft SEIS characterized the complex interaction of the cooling canal system with the environment and described potential impacts of continued cooling canal operation on surface water, groundwater, and biologic resources. These concerns were addressed by the NRC staff in the final SEIS.

The NRC staff made the final SEIS (FSEIS) for the Turkey Point Units 3 and 4 subsequent license renewal application publicly available on October 25, 2019 (ADAMS Package Accession No. ML19295F526). All substantive comments received during the draft SEIS comment period are included in Appendix A of the FSEIS. Neither FPL nor the NRC staff identified any new and significant information related to Category 1 issues that would call into question the conclusions in the GEIS, with respect to the subsequent license renewal period of extended operation for Turkey Point Units 3 and 4. In the FSEIS, the NRC staff recommended that the Commission determine that the adverse environmental impacts of subsequent license renewal for Turkey Point are not so great that preserving the option of subsequent license renewal for energy-planning decisionmakers would be unreasonable. This recommendation is based on: (1) the analysis and findings in the GEIS; (2) the NRC staff's review of information provided in the environmental report and other documents submitted by FPL; (3) the NRC staff's consultation with Federal, State, local, and Tribal agencies; (4) the NRC staff's independent environmental

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[1] 78 FR 37281. U.S. Nuclear Regulatory Commission. Final Rule, "Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses." *Federal Register* 78 FR 37281. June 20, 2013.
[2] U.S. Nuclear Regulatory Commission. 2013. NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," Rev. 1, Vols. 1–3 (ADAMS Accession Nos. ML13106A241, ML13106A242, and ML13106A244). June 2013.

review; and (5) the NRC staff's consideration of public comments received during the scoping process and on the Draft Supplemental Environmental Impact Statement. Pursuant to 10 CFR 51.102(b) and 10 CFR 51.103(a)(1)-(5), the NRC staff has prepared this concise public record of decision (ROD) to document its action on the Turkey Point Units 3 and 4 subsequent license renewal application. In accordance with 10 CFR 51.103(c), this ROD incorporates by reference the material contained in the FSEIS.

DECISION

Pursuant to 10 CFR 54.29, "Standards for issuance of a renewed license," a renewed license may be issued by the Commission if the Commission finds, in part, that the license renewal application satisfies the requirements of 10 CFR Part 54, and any applicable requirements of Subpart A of 10 CFR Part 51 have been satisfied; pursuant to 10 CFR 51.102, this includes the completion of a Record of Decision.

This Record of Decision and the FSEIS, which is incorporated by reference herein, document the NRC's final decision regarding the environmental review of the Turkey Point Units 3 and 4 subsequent license renewal application, in accordance with 10 CFR 51.103(a)(5), that the adverse environmental impacts of subsequent license renewal for Turkey Point Units 3 and 4 are not so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable.

In making its final decision on the proposed Federal action to authorize the continued operation of Turkey Point Units 3 and 4 through July 19, 2052, and April 10, 2053, respectively, the NRC must make a favorable safety finding. The purpose of the NRC's safety review of a license renewal application is to determine if the applicant has adequately demonstrated that the effects of aging will not adversely affect the intended functions of any safety-related structures or components as specified in 10 CFR 54.4 and 10 CFR 54.21. The applicant must demonstrate that the effects of aging will be adequately managed so that the intended functions will be maintained in accordance with the plants' current licensing basis throughout the license renewal period. The NRC staff documented the results of its safety review in its "Safety Evaluation Report Related to the Subsequent License Renewal of Turkey Point Nuclear Generating Units 3 and 4," issued July 22, 2019 (ADAMS Accession No. ML19191A057).

Further, the Advisory Committee on Reactor Safeguards (ACRS) completed its review and report in accordance with 10 CFR 54.25, "Report of the Advisory Committee on Reactor Safeguards," with respect to the application for subsequent renewal of the Turkey Point Units 3 and 4 renewed operating licenses. The ACRS completed its review during its 666th meeting, held on September 4–6, 2019, and documented its findings recommending subsequent renewal of the Turkey Point Unit 3 and 4 licenses in a letter to the Commission dated October 7, 2019 (ADAMS Accession No ML19283A168).

Several requests for hearing and petitions to intervene were filed in response to the notice of opportunity for hearing that was published on May 2, 2018 (83 FR 19304). An NRC Atomic Safety and Licensing Board (Board) was appointed and an adjudicatory proceeding was commenced. The Board granted two petitions to intervene and admitted several contentions on March 7, 2019 (LBP-19-3) (ADAMS Accession No. ML19067A003). The Board later dismissed the remaining contentions in a decision issued on July 8, 2019 (LBP-19-6) (ADAMS Accession

No. ML19189A252), and denied all outstanding contentions and terminated the proceeding before the Board in its Memorandum and Order of October 24, 2019 (LBP-19-8) (ADAMS Accession No. ML19297F366). Appeals from the Board's decisions in LBP-19-3, LBP-19-6 and LBP-19-8, and the Board's referred ruling in LBP-19-3, are pending before the Commission at this time.

PURPOSE AND NEED

The purpose and need for the proposed Federal action (issuance of subsequent renewed licenses for Turkey Point Units 3 and 4) is to provide an option that allows for power generation capability beyond the term of the current renewed nuclear power plant operating licenses to meet future system generating needs. Such needs may be determined by energy-planning decisionmakers such as State regulators, utility owners, and Federal agencies other than the NRC. This definition of purpose and need reflects the NRC's recognition that, unless there are findings in the NRC's safety review (required by the Atomic Energy Act) or findings in the NRC's environmental analysis (required by NEPA) that would lead the NRC to reject a license renewal application, the NRC does not have a role in energy-planning decisions as to whether a particular nuclear power plant should continue to operate.

The issuance of a renewed license is just one of a number of conditions that a licensee must meet to be able to operate its nuclear power plant during the license renewal term. Ultimately, the appropriate energy-planning decisionmakers and Florida Power & Light will decide whether the plants will continue to operate based on the need for power or other factors within the State and County's jurisdiction or the purview of the owners.

NRC EVALUATION OF THE PROPOSED ACTION AND ALTERNATIVES

In license renewal environmental reviews, the NRC considers the environmental consequences of the proposed action (i.e., renewing the operating license), the environmental consequences of the no-action alternative (i.e., not renewing the operating license), and the environmental consequences of various alternatives for replacing the nuclear power plant's generating capacity. Section 102(2)(C)(iii) of NEPA and the NRC's regulations require the consideration of alternatives to the proposed action in the EIS. In this case, the proposed action is issuance of renewed operating licenses for Turkey Point Units 3 and 4, which will authorize the applicant to operate the plant for an additional period beyond the expiration date of the current licenses. Chapter 2 of the SEIS, "Alternatives Including the Proposed Action," and Chapter 4, "Environmental Consequences and Mitigating Actions," present the NRC staff's evaluation and analysis of the environmental impacts of the proposed action and alternatives to license renewal that were considered in detail, as well as those alternatives that were eliminated from detailed study. The evaluation considered environmental impacts of each alternative across the following impact areas: land use and visual resources, air quality and noise, geologic environment, water resources, terrestrial resources, aquatic resources, special status species, historic and cultural resources, socioeconomics, human health, environmental justice, and waste management. In addition to replacement power alternatives, the SEIS evaluates an alternative cooling water system to mitigate potential impacts associated with the continued use of the existing cooling canal system.

As explained in the purpose and need for the proposed Federal action, outside of the safety and environmental reviews, the NRC does not have a role in the energy planning decisions as to whether a particular nuclear power plant should continue to operate. Should the operating license not be renewed and the nuclear plant shuts down at the end of its current license, the appropriate energy planning decisionmakers will decide how best to replace the nuclear power plant's generating capacity. In evaluating alternatives to license renewal, the NRC considered energy technologies or options currently in commercial operation, as well as technologies not currently in commercial operation but likely to be commercially available by the time the current Turkey Point Units 3 and 4 operating licenses expire.

For a replacement power alternative to be considered reasonable, it must be both (1) commercially viable on a utility scale and (2) operational before the reactor's operating license expires or (3) expected to become commercially viable on a utility scale and operational before the expiration of the reactor's operating license. The current renewed operating licenses for Turkey Point Units 3 and 4 expire on July 19, 2032, and April 10, 2033, respectively. Therefore, to be considered in this evaluation, reasonable alternatives had to be available (i.e., constructed, permitted, and connected to the grid) by those dates. To determine whether alternatives were reasonable, or likely to be commercially suitable to replace Turkey Point, the NRC staff reviewed energy-relevant statutes, regulations, and policies; the state of technologies; and information on energy outlook from sources such as the Energy Information Administration, other organizations within the U.S. Department of Energy, industry sources and publications, and information submitted by FPL in its environmental report.

<u>Evaluation of Alternatives</u>

i. No-Action Alternative

At some point, all operating nuclear power plants will permanently cease operations and undergo decommissioning. The no-action alternative represents a decision by the NRC to not issue renewed operating licenses to a nuclear power plant beyond the current operating license term. Under the no-action alternative, the NRC does not issue the subsequent renewed operating licenses for Turkey Point, such that the units would shut down at or before the expiration of the current licenses in July 2032 (Unit 3) and April 2033 (Unit 4). The GEIS describes the environmental impacts that arise directly from permanent plant shutdown. The NRC expects shutdown impacts to be relatively similar whether they occur at the end of the current license term (i.e., after 60 years of operation) or at the end of a subsequent renewed license term (i.e., after 80 years of operation).

After permanent shutdown, plant operators will initiate decommissioning in accordance with 10 CFR 50.82, "Termination of license." The decommissioning GEIS (ADAMS Accession Nos. ML023470327, ML023500228, and ML023500295) describes the environmental impacts from decommissioning a nuclear power plant and related activities. The analysis in the decommissioning GEIS bounds the environmental impacts of decommissioning at such time as FPL terminates reactor operations at Turkey Point. Chapter 4 of the license renewal GEIS and Section 4.15.2 of the Turkey Point SEIS describe the incremental environmental impacts of subsequent license renewal on decommissioning activities.

Termination of operations at Turkey Point would result in the total cessation of electrical power production by Turkey Point Units 3 and 4. The no-action alternative does not expressly meet the purpose and need of the proposed action because the no-action alternative does not provide a means of delivering baseload power to meet future electric system needs. Assuming that a need exists for the power generated by Turkey Point Units 3 and 4 at the time of their shutdown, the no-action alternative would likely create a need for a replacement power alternative. The NRC staff's environmental review includes a comparison of the environmental impacts of subsequent license renewal with the impacts of a range of energy sources that might be chosen in the event that the current renewed Turkey Point licenses are not subsequently renewed.

ii. Alternative Energy Sources

In evaluating alternatives to subsequent license renewal, the NRC considered energy technologies or options currently in commercial operation, as well as technologies not currently in commercial operation, but likely to be commercially available by the time the current Turkey Point renewed operating licenses expire.

The GEIS presents an overview of some alternative energy technologies but does not conclude which alternatives are most appropriate. Because alternative energy technologies are continually evolving in capability and cost, and because regulatory structures have changed to either promote or impede the development of particular technologies, the analyses in the FSEIS rely on a variety of sources of information to determine which alternatives would be available and commercially viable when the current licenses expire. FPL's environmental report provides a discussion of replacement power alternatives. In addition to the information FPL provided in its environmental report, the NRC staff's analyses relied on appropriate Federal, State, and industry information sources.

In total, the NRC staff considered 16 replacement power alternatives to the proposed action and eliminated 13 of these from detailed study because of existing technical, resource availability, or commercial limitations. These limitations are likely to continue when the current Turkey Point renewed licenses expire, rendering these alternatives not feasible or commercially viable. The no-action alternative (i.e., not issuing subsequent renewed licenses) was also considered. Alternatives considered, but eliminated from detailed study were as follows:

solar power
wind power
biomass power
demand-side management
hydroelectric power
geothermal power
wave and ocean energy
municipal solid waste
petroleum-fired power
coal-fired power
fuel cells
purchased power
delayed retirement of other generating facilities.

The basis for the elimination of each of these alternatives is explained in Section 2.3 of the final SEIS.

This left three reasonable replacement power alternatives for in-depth evaluation:

- new nuclear generation
- natural gas combined cycle (NGCC)
- combination alternative (NGCC and solar power)

These three alternatives are described in Sections 2.2.2.1 through 2.2.2.3 of the FSEIS, and NRC staff's in-depth evaluation of these alternatives is presented in Chapter 4 of the FSEIS. The alternatives selected for detailed evaluation in the FSEIS are briefly described below.

New Nuclear Alternative

The NRC staff considers the construction of a new nuclear plant to be a reasonable alternative to Turkey Point subsequent license renewal. The NRC staff determined that there may be sufficient time for FPL to prepare and submit an application, build, and operate two new nuclear units using a certified design before the Turkey Point Units 3 and 4 licenses expire in 2032 and 2033.

In 2018, as part of a separate licensing action, the NRC issued combined licenses (COLs) to FPL for the construction and operation of two new Westinghouse AP1000 reactor units at the Turkey Point site. For the purpose of this subsequent license renewal analysis, the NRC staff assumed two separate Westinghouse AP1000 reactors would replace Turkey Point Units 3 and 4. For the new nuclear alternative, the replacement power facility would be located within the Turkey Point property, but outside the current footprints of Turkey Point Units 3 and 4. Accordingly, the heat rejection demands of these new nuclear reactors would also be similar to those of Turkey Point Units 3 and 4. As stated in FPL's environmental report, the new nuclear alternative would use a mechanical draft cooling tower system. This closed-cycle cooling system would primarily use reclaimed wastewater from the Miami-Dade Water and Sewer Department, with saltwater produced from radial collection wells under Biscayne Bay used as a temporary backup source.

The NRC staff also considered the installation of multiple small modular reactors as a new nuclear alternative to renewing the Turkey Point Unit 3 and 4 licenses. Small modular reactors generate approximately 300 MW or less, so they have lower initial capacity than that of traditional large-scale units. However, they have greater siting flexibility because they can fit in locations not large enough to accommodate traditional nuclear reactors. The NRC staff assumes that the resource requirements and key characteristics associated with constructing and operating small modular reactors would be bounded by the larger nuclear units evaluated in the SEIS.

Natural Gas Combined-Cycle Alternative

The NRC staff considers the construction of a natural gas combined-cycle power plant to be a reasonable alternative to Turkey Point subsequent license renewal because natural gas is a feasible, commercially available option for providing baseload electrical generating capacity beyond the expiration of Turkey Point's current licenses.

Baseload natural gas combined-cycle power plants have proven their reliability and can have capacity factors as high as 87 percent. For this alternative, the NRC staff assumes that three natural gas units would be constructed and operated to replace Turkey Point's generating capacity. Together, the three units would collectively replace Turkey Point's approximate net generating capacity of 1500 MWe.

The NRC staff assumes that the natural gas combined-cycle plant would use a closed-cycle cooling system with mechanical draft cooling towers. Because of the high overall thermal efficiency of this type of plant, the natural gas combined-cycle alternative would require less cooling water than Turkey Point subsequent license renewal. Onsite visible structures could include the cooling towers, exhaust stacks, intake and discharge structures, transmission lines, natural gas pipelines, and an electrical switchyard.

Combination Alternative

The NRC staff considers construction of an alternative that combines construction of new natural gas combined-cycle and new solar power generating facilities to be a reasonable alternative to Turkey Point subsequent license renewal because these sources, when combined, provide a feasible, commercially available option for providing baseload electrical generating capacity beyond the expiration of Turkey Point's current licenses. The staff assumes that the natural gas combined-cycle facility and one of the four solar plants would be located within the Turkey Point property and would use existing available site infrastructure to the extent practicable. The other three solar facilities would be located at offsite locations within the region of influence, specifically within Miami-Dade and Broward counties.

The natural gas portion of the combination alternative would be generated using a natural gas combined-cycle plant. Although similar in function and appearance to the natural gas plant described above, the natural gas plant considered under the combination alternative would have slightly less generating capacity. Specifically, this slightly smaller plant would collectively replace 1,420 MWe of Turkey Point's approximate net generating capacity.

The NRC staff assumes that the natural gas plant would similarly use a closed-cycle cooling system with mechanical draft cooling towers.

The NRC staff considers the construction of solar photovoltaic facilities to be a reasonable alternative to subsequent license renewal when combined with natural gas combined-cycle facilities.

The solar portion of the combination alternative would be generated using a utility-scale solar photovoltaic facility comprised of four units. Operating at a 26 percent capacity factor, the solar units collectively would have an approximate net generating capacity of 80 MWe. When combined with the natural gas portion of this alternative, the total power produced would be sufficient to replace Turkey Point's approximate net generating capacity of 1500 MWe.

iii. Alternative Cooling Water Source

The NRC staff also evaluated in the FSEIS an alternative cooling water system technology for Turkey Point Units 3 and 4 that might be used to mitigate the potential impacts associated with continued use of the existing cooling canal system. The purpose of this analysis is for the NRC staff to compare an alternative closed-cycle cooling system approach with the proposed action to inform the NRC's licensing decision, decisions by other decisionmakers, and the public, as applicable, under NEPA. However, the NRC has neither the statutory nor the regulatory authority to determine which cooling water system or technology should be used, or to decide other permitting issues, for which the State of Florida has been delegated regulatory authority under the Clean Water Act.

The NRC staff's analysis of the alternative cooling water system draws upon an application, which FPL submitted to the NRC in 2009 for COLs to build and operate two new nuclear reactors (Turkey Point Units 6 and 7) on the Turkey Point site. The NRC staff conducted an environmental review of that COL application and published it as NUREG–2176, "Environmental Impact Statement for Combined Licenses (COLs) for Turkey Point Nuclear Plant Units 6 and 7" (ADAMS Package Accession No. ML16335A219). Section 3.2.2.2 of the COL EIS describes a cooling water system alternative to Turkey Point's existing cooling canal system that consists of onsite mechanical draft cooling towers. Under the cooling water system alternative that is evaluated by the NRC staff in the subsequent license renewal FSEIS, Turkey Point Units 3 and 4 would each use three similar closed-cycle wet-cooling towers (six cooling towers in total) to dissipate heat from the reactor cooling water systems.

As in the new nuclear alternative, the primary source of cooling water is assumed to be reclaimed wastewater.

The CCS would continue to operate regardless of the proposed Turkey Point license renewal because it supports retired fossil fuel Units 1 and 2. FPL plans to continue to use water from the CCS to support these units' operation in synchronous condenser mode over the course of the proposed subsequent license renewal period. Additionally, fossil fuel Unit 5 would remain in operation and would continue to discharge blowdown to the CCS. Furthermore, requirements of the October 7, 2015, Consent Agreement between FPL and Miami-Dade County and the June 20, 2016, Consent Order between FPL and the Florida Department of Environmental Protection would continue to apply.

iv. Summary

In the FSEIS for the Turkey Point subsequent license renewal, the NRC staff considered the environmental impacts associated with subsequent license renewal and with alternatives to subsequent license renewal, including alternative power generation technologies; the impacts of not renewing the Turkey Point Unit 3 and 4 operating licenses (the no-action alternative); and the impacts of an alternative to operation of the cooling canal system. The FSEIS concludes that environmental impacts of the proposed action (subsequent renewal of the Turkey Point operating licenses) would be SMALL for all impact categories except for groundwater resources and aquatic resources. The impacts to groundwater resources range from SMALL to MODERATE because of groundwater use conflicts during subsequent license renewal. Due to impingement, entrainment, and thermal impacts on the aquatic organisms in the cooling canal system, the impact of the Turkey Point subsequent license renewal to aquatic resources would be SMALL to MODERATE.

As summarized in Table 2-2 of the FSEIS ("Summary of Environmental Impacts of the Proposed Action and Alternatives," reproduced below in Table 1), each of the three reasonable replacement power alternatives have environmental impacts in at least two resource areas that are greater than the environmental impacts of the proposed action of subsequent license renewal. In addition, the replacement power alternatives also involve the environmental impacts inherent to new construction projects. If the NRC adopts the no-action alternative and does not issue subsequent renewed licenses for Turkey Point, energy-planning decisionmakers would likely implement one of the three replacement power alternatives discussed in-depth in Chapter 4 of the FSEIS. Based on the NRC staff's review of these three replacement power alternatives, the no-action alternative, and the proposed action, the staff concludes that the environmentally preferred alternative is the proposed action of subsequent license renewal. Therefore, the NRC staff proposes to recommend that the NRC issue subsequent renewed operating licenses for Turkey Point Units 3 and 4.

Table 1 Summary of Environmental Impacts of the Proposed Action and Alternatives

Impact Area (Resource)	Turkey Point Subsequent License Renewal (Proposed Action)	No-Action Alternative	New Nuclear Alternative	Natural Gas Combined-Cycle Alternative	Combination Alternative (Natural Gas Combined-Cycle and Solar Photovoltaic)	Cooling Water System Alternative
Land Use	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to LARGE	SMALL
Visual Resources	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to LARGE	SMALL to MODERATE
Air Quality	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL
Noise	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Geologic Environment	SMALL	SMALL	SMALL	SMALL	MODERATE	SMALL
Surface Water Resources	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Groundwater Resources	SMALL to MODERATE	SMALL	SMALL	SMALL	SMALL	SMALL
Terrestrial Resources	SMALL	SMALL	MODERATE	MODERATE	MODERATE	MODERATE
Aquatic Resources	SMALL to MODERATE	SMALL	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE	MODERATE
Special Status Species and Habitats	See Note[(a)]	See Note[(b)]	See Note[(b)]	See Note[(b)]	See Note[(b)]	See Note[(b)]

Historic and Cultural Resources	See Note(c)	See Note(d)	See Note(e)	See Note(e)	See Note(f)	See Note(e)
Socioeconomics	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL	SMALL
Transportation	SMALL	SMALL	SMALL to LARGE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Human Health	SMALL(g)	SMALL(g)	SMALL(g)	SMALL(g)	SMALL(g)	SMALL(g)
Environmental Justice	See Note(h)	See Note(i)	See Note(j)	See Note(j)	See Note(k)	See Note(j)
Waste Management and Pollution Prevention	SMALL(l)	SMALL(l)	SMALL (l)	SMALL	SMALL	SMALL

(a) The NRC staff concludes that Turkey Point subsequent license renewal is likely to adversely affect the American crocodile and the eastern indigo snake, and may result in adverse modification to designated critical habitat of the American crocodile. The NRC staff concludes that proposed action may affect, but is not likely to adversely affect, the Florida panther, West Indian manatee, red knot, wood stork, loggerhead sea turtle, green sea turtle, leatherback sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, and smalltooth sawfish. The NRC staff concludes that the proposed action would result in no adverse modification to designated critical habitat of the West Indian manatee. The NRC staff's evaluation of impacts to federally listed species and critical habitats under the U.S. Fish and Wildlife Service's jurisdiction appears in the NRC's Biological Assessment (ADAMS Accession No. ML18353A835). The FWS's separate evaluation and conclusions appear in a July 25, 2019, biological opinion (ADAMS Accession No. ML19221B583), which is described in Section 4.8.1.1 of this SEIS. The NRC staff's evaluation of impacts to federally listed species and critical habitats under the National Marine Fisheries Service's jurisdiction appears in Section 4.8.1.1 of this SEIS. The NRC staff concludes that the proposed action would have no adverse effects on Essential Fish Habitat. The NRC staff's evaluation of impacts to Essential Fish Habitat appears in Section 4.8.1.2 of this SEIS. The NRC staff concludes that the proposed action would not affect the sanctuary resources of the Florida Keys National Marine Sanctuary. The NRC staff's evaluation of sanctuary resources appears in Section 4.8.1.3 of this SEIS.

(b) The types and magnitudes of adverse impacts to species listed pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.), designated critical habitat, and Essential Fish Habitat would depend on Turkey Point shutdown activities, the proposed alternative site, plant design, and operation, as applicable, and on the listed species and designated critical habitats present when the alternative is implemented. Therefore, the NRC staff cannot forecast a particular level of impact for this alternative.

(c) Based on (1) the location of National Register of Historic Places-eligible historic properties within the area of potential effect, (2) tribal input, (3) FPL's cultural resource protection plans, (4) the fact that no license renewal-related physical changes or ground-disturbing activities would occur, (5) Florida State Historic Preservation Office input, and (6) cultural resource assessment, license renewal would not adversely affect any known historic properties (Title 36 of the *Code of Federal Regulations* 800.4(d)(1), "No Historic Properties Affected").

(d) As a result of facility shutdown, land-disturbing activities or dismantlement are not anticipated as these would be conducted during decommissioning. Therefore, facility shutdown would have no immediate effect on historic properties or historic and cultural resources.

(e) Since the alternative would be located at the Turkey Point site, which has a low archeological potential, and avoidance of significant resources would be possible, this alternative would not adversely affect known historic properties.

(f) The impacts from the construction and operation of the solar component would depend on where solar facilities are constructed. The historic and cultural resource impact could range from no adverse effect to adverse effect.

(g) The chronic effects of electromagnetic fields on human health associated with operating nuclear power and other electricity generating plants are uncertain.

(h) There would be no disproportionately high and adverse impacts to minority and low-income populations.

(i) A reduction in tax revenue resulting from the shutdown of Turkey Point could decrease the availability of public services in the Turkey Point area. However, the effects to minority and low-income populations would not be disproportionately high and adverse.

(j) Based on the analysis of human health and environmental impacts presented in this SEIS, the location of the alternative, and the assumed alternative design and characteristics, this alternative would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

(k) This alternative would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations. However, this determination would depend on the location of the solar facilities. Therefore, the NRC staff cannot determine whether the solar portion of the combination alternative would result in disproportionately high and adverse human health and environmental effects on minority and low-income populations.

(l) NUREG–2157, "Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel," (ADAMS Accession No. ML14198A440) discusses the environmental impact of spent fuel storage for the timeframe beyond the licensed life for reactor operations.

UPDATED STATUS OF ENDANGERED SPECIES ACT SECTION 7 CONSULTATION

In conjunction with its review of the license renewal application, the NRC staff conducted consultation under Section 7 of the Endangered Species Act (ESA) of 1973, as amended, with the National Marine Fisheries Service (NMFS). Appendix C.1 of the FSEIS describes the status of the staff's consultation with the NMFS, which was not yet concluded when the staff completed the FSEIS. On April 1, 2019, the NRC staff requested the NMFS's concurrence with the staff's determinations that the proposed action may affect, but is not likely to adversely affect, the loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), leatherback sea turtle (*Dermochelys coriacea*), hawksbill sea turtle (*Eretmochelys imbricata*), and smalltooth sawfish (*Pristis pectinata*) (ADAMS Accession No. ML19091A128). On June 7, 2019, the NRC staff transmitted its determinations for two additional species, Kemp's ridley sea turtle (*Lepidochelys kempii*) and Nassau grouper (*Epinephelus striatus*) to the NMFS (ADAMS Accession No. ML19158A503). The staff determined that the proposed action may affect, but is not likely to adversely affect, the Kemp's ridley sea turtle. The staff also determined that the proposed action would have no effect on the Nassau grouper, because NMFS had previously determined in a 2017 consultation with the NRC that the Nassau grouper would not occur in the action area, and the staff had identified no new information during its review for subsequent license renewal indicating that this species would occur in the action area.

On October 22, 2019, the NMFS concurred with the NRC staff's determinations that the proposed action may affect, but is not likely to adversely affect, the loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), leatherback sea turtle (*Dermochelys coriacea*), hawksbill sea turtle (*Eretmochelys imbricata*), Kemp's ridley sea turtle (*Lepidochelys kempii*), and smalltooth sawfish (*Pristis pectinata*). The NMFS also concluded that the proposed action may affect, but is not likely to adversely affect, the Nassau grouper (*Epinephelus striatus*). The NMFS's concurrence concluded consultation for the proposed Turkey Point license renewal. Accordingly, the NRC has fulfilled its obligations under ESA Section 7(a)(2) with respect to the proposed action for federally listed species and critical habitats under the jurisdiction of the NMFS.

With respect to federally listed species and critical habitats under the jurisdiction of the U.S. Fish and Wildlife Service (FWS), the NRC staff consulted with the FWS on the proposed action in 2018 and 2019. On July 25, 2019, the FWS issued a biological opinion for Turkey Point. In its opinion, the FWS concluded that the continued operation of Turkey Point through the duration of the proposed subsequent license renewal period is not likely to jeopardize the continued existence of the American crocodile (*Crocodylus acutus*) or eastern indigo snake (*Drymarchon corais couperi*) and will not adversely modify the critical habitat of the American crocodile. The biological opinion includes an incidental take statement (ITS) applicable to the American crocodile and eastern indigo snake. The ITS's terms and conditions are nondiscretionary and must be undertaken by the NRC so that they become binding conditions of the renewed licenses, if granted, for the exemption in ESA Section 7(o)(2) to apply. Accordingly, the NRC will include conditions in the Turkey Point subsequent renewed facility operating licenses requiring FPL to adhere to the specific requirements within the ITS. Appendix A.1 of the FSEIS describes the staff's consultation with the FWS in more detail.

MITIGATION MEASURES

The NRC has taken all practicable measures within its jurisdiction to avoid or minimize environmental harm from the proposed action (subsequent license renewal). The NRC has determined that no additional mitigation measures are warranted and therefore is not imposing any license conditions in connection with mitigation measures for the continued operation of Units 3 and 4, apart from insertion of a condition regarding the ITS in Appendix B (Environmental Protection Plan) of the current licenses, which will continue in effect during the subsequent license renewal term. The NRC notes that Turkey Point is also subject to requirements including permits, authorizations, and regulatory orders imposed by other Federal, State, and local agencies governing facility operation, including the cooling canal system. For example, the National Pollutant Discharge Elimination System (NPDES) permit issued to FPL imposes effluent limitations and monitoring requirements as well as best management practices to ensure that impacts to water quality and aquatic life are minimized. The NRC is not requiring any new environmental monitoring programs beyond what is required for the NPDES permits or otherwise required under the NRC's regulations, as described in the FSEIS.

CONSIDERATION OF EMERGING INFORMATION AND COMMENTS ON THE FSEIS

Issuance of 2019 Annual Monitoring Report

The NRC staff's FSEIS includes consideration of FPL's annual monitoring reports through the period ending May 31, 2018. In August 2019, FPL issued the Turkey Point Plant Annual Monitoring Report for 2019. This report covers the period June 1, 2018, through May 31, 2019. The report summarizes the latest analytical results from FPL's meteorological, hydrologic, water quality, and ecological community monitoring that covers the Turkey Point CCS, Biscayne Bay, Card Sound, marshlands, mangrove areas, and canals adjacent to the CCS. FPL conducts this monitoring to assess the horizontal and vertical effects and extent of CCS water on existing and projected surface water, groundwater and ecological conditions surrounding Turkey Point. FPL conducts this monitoring under the auspices of the State of Florida's Department of Environmental Protection (FDEP), SFWMD, and the Miami-Dade County Department of Environmental Resources Management (DERM).

The NRC staff was unable to incorporate the information from the 2019 monitoring report in the Turkey Point FSEIS because FPL had not published the 2019 report by the time the NRC staff's environmental review concluded and the Turkey Point FSEIS was being prepared for publication. In the Turkey Point FSEIS, the NRC staff considered and carefully evaluated analytical results and conclusions contained in FPL's 2018 Turkey Point Plant Annual Monitoring Report, as summarized throughout the FSEIS including, but not limited to, sections 3.5.1.4, 3.5.2.2, 3.6.2, and 3.7.4.

Following FPL's issuance of the 2019 monitoring report, the NRC staff examined the report to determine whether the latest published data present new and significant information such that a supplement to the Turkey Point FSEIS would be required, in accordance with 10 CFR 51.92(a). The staff's review identified no substantial changes in monitoring results or trends for hydrologic parameters, surface water quality, groundwater quality, or ecological communities that would change any conclusions presented in the FSEIS. Therefore, the NRC staff determined that no supplement to the Turkey Point FSEIS was required.

Comments on the FSEIS

On November 1, 2019, the EPA issued the Notice of Availability for the FSEIS regarding the Turkey Point Units 3 and 4 subsequent license renewal application (84 FR 58713). On December 2, 2019, NRC staff received a letter from EPA Region 4 providing comments on the FSEIS. The NRC staff has carefully reviewed the letter and the comments attached thereto. After thorough review and consideration, the staff has determined that the issues discussed in the EPA's comments were previously considered and addressed in the FSEIS and Appendix A thereto, as further amplified below in response to EPA's comments. Therefore, the staff has concluded that no further evaluation of these comments is required, and no change to the staff's conclusions is warranted.

First, in its comments on the FSEIS, the EPA reaffirmed its request that the NRC add language to the renewed operating licenses for Turkey Point Units 3 and 4, or to the ROD, requiring FPL to implement alternative water quality mitigation measures should FPL be unable to achieve mandated groundwater remediation objectives prescribed by the Florida Department of Environmental Protection and Miami-Dade County associated with the cooling canal system operations. As previously described in the NRC staff's October 25, 2019, letter to EPA (ADAMS Accession No. ML19295F527) and in the NRC staff's responses to EPA and other stakeholder comments contained in Appendix A, Section A.2.11, of the FSEIS, the NRC does not have regulatory authority to require FPL to comply with the Clean Water Act; such regulatory authority resides with the EPA and its delegee, the State of Florida. Likewise, the NRC does not have regulatory authority to require FPL to comply with consent agreements or consent orders issued by the FDEP or the DERM and, therefore, cannot make compliance with orders issued by other agencies a condition of the NRC license. Neither does the NRC have the regulatory authority to require that FPL implement an alternative closed-loop cooling water system or other measures as a license condition if requirements imposed by the FDEP or DERM are unsuccessful in achieving their objectives. Similarly, the NRC's regulatory authority does not enable it to incorporate such language into this ROD.

Second, the NRC staff acknowledges the EPA's observation that a discussion in Section 3.5.1.1 ("Potential for Flooding at the Turkey Point Site") of the FSEIS does not describe the detailed model that was used by FPL to conduct flooding and storm surge analyses for the Turkey Point site, and EPA's recommendation that the NRC provide a description of the modeling and associated rationale supporting storm surge and flooding analyses in future assessments. In this regard, as noted in the FSEIS, the flood hazard analysis for Turkey Point Units 3 and 4 was performed by FPL in connection with the NRC's oversight of the current operating licenses at Turkey Point Units 3 and 4, and not in connection with the subsequent license renewal. More specifically, in 2012, the Commission ordered all nuclear power plant licensees to conduct appropriate flood hazard revaluations based on recommendations from the NRC's Japan Near-Term Task Force that was commissioned after the March 11, 2011, Great Tohoku Earthquake and subsequent tsunami, impacting the Fukushima Dai-ichi nuclear power plants. As discussed in the FSEIS at page 3-42, FPL submitted its updated flooding analysis on June 29, 2017, as required; a detailed description of that analysis ("Turkey Point Nuclear Generating Station Flooding Focused Evaluation Summary") is contained in the document cited in the FSEIS at page 3-42 as NRC 2017b (ADAMS Accession No. ML17212B180). Following its review of FPL's analysis, the NRC staff determined that FPL conducted the flood hazard reevaluation for

Turkey Point Units 3 and 4 using NRC-approved modeling approaches and applicable guidance, including Nuclear Energy Institute (NEI) 16-05, Revision 1, "External Flooding Assessment Guidelines" (ADAMS Accession No. ML16165A178). The NRC staff's letter approving FPL's analysis, dated July 3, 2018, is available at ADAMS Accession No. ML18158A548; this document was inadvertently not cited on page 3-42 of the FSEIS, and should have been identified and listed in Chapter 6. More generally, historic and current information relating to the scope, process, relevant guidance, and status of the facility-specific flood hazard reevaluation activities can be found on the NRC's public web site at https://www.nrc.gov/reactors/operating/ops-experience/japan-dashboard/flooding.html.

DETERMINATION

Based on the NRC staff's (a) independent review, analysis, and evaluation contained in the subsequent license renewal FSEIS; (b) careful consideration of all of the identified social, economic, and environmental factors; (c) input received from other agencies, organizations, and the public; and (d) consideration of mitigation measures, the NRC has determined that the standards for the issuance of a subsequently renewed operating license, with respect to the environmental matters as described in 10 CFR 54.29(b), have been met and that the requirements of Section 102 of NEPA have been satisfied. The NRC has determined that the adverse environmental impacts or issuing subsequent renewed operating licenses for Turkey Point Units 3 and 4 are not so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable.

Dated at Rockville, MD, this 4th day of December, 2019,

APPROVED BY:

/RA/

Anna H. Bradford, Director
Division of New and Renewed Licenses
Office of Nuclear Reactor Regulation

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

FLORIDA POWER & LIGHT COMPANY

DOCKET NO. 50-250

TURKEY POINT NUCLEAR GENERATING UNIT NO. 3

SUBSEQUENT RENEWED FACILITY OPERATING LICENSE NO. DPR-31

The U.S. Nuclear Regulatory Commission (the Commission) having previously made the findings set forth in Renewed License No. DPR-31 issued on June 6, 2002, has now found that:

a. The application for Subsequent Renewed Facility Operating License No. DPR-31 filed by Florida Power and Light Company, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I and all required notifications to other agencies or bodies have been duly made;

b. Actions have been identified and have been or will be taken with respect to (1) managing the effects of aging during the subsequent period of extended operation on the functionality of structures and components that have been identified to require review under 10 CFR 54.21(a)(1), and (2) time-limited aging analyses that have been identified to require review under 10 CFR 54.21(c), such that there is reasonable assurance that the activities authorized by this subsequent renewed operating license will continue to be conducted in accordance with the current licensing basis, as defined in 10 CFR 54.3, for the Turkey Point Unit 3 plant, and that any changes made to the plant's current licensing basis in order to comply with 10 CFR 54.29(a) are in accord with the Act and the Commission's regulations;

c. The facility will operate in conformity with the application, as amended, the provisions of the Act, and the rules and regulations of the Commission;

d. There is reasonable assurance (i) that the facility can be operated at steady state power levels up to 2644 megawatts thermal in accordance with this subsequent renewed operating license without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the rules and regulations of the Commission;

e. Florida Power and Light Company is technically and financially qualified to engage in the activities authorized by this subsequent renewed operating license in accordance with the rules and regulations of the Commission;

f. The applicable provisions of 10 CFR Part 140 have been satisfied;

g. The subsequent renewal of this renewed operating license will not be inimical to the common defense and security or to the health and safety of the public; and

h. After weighing the environmental, economic, technical and other benefits of the facility against environmental costs and considering available alternatives, the issuance of Subsequent Renewed Facility Operating License No. DPR-31 is in accordance with

10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

On the basis of the foregoing findings regarding this facility, Renewed Facility Operating License No. DPR-31, issued on June 6, 2002, is superseded by Subsequent Renewed Facility Operating License No. DPR-31, which is hereby issued to Florida Power and Light Company (FPL), to read as follows:

1. This subsequent renewed operating license applies to the Turkey Point Nuclear Generating Unit No. 3 nuclear power reactor, a pressurized, light water moderated and cooled reactor, and associated steam generators and electrical generating equipment (the facility). The facility is located on the applicant's Turkey Point site in Miami-Dade County, about 25 miles south of Miami, Florida, and is described in the Final Safety Analysis Report as supplemented and amended, and the Environmental Report as supplemented and amended.

2. Subject to the conditions and requirements incorporated herein, the Commission hereby licenses FPL:

   A. Pursuant to Section 104b of the Atomic Energy Act of 1954, as amended (the Act), and 10 CFR Part 50, "Licensing of Production and Utilization Facilities," to possess, use, and operate the facility as a utilization facility at the designated location on the Turkey Point site, in accordance with the procedures and limitations set forth in this subsequent renewed operating license;

   B. Pursuant to the Act and 10 CFR Part 70, to receive, possess, and use at any time special nuclear material as reactor fuel, in accordance with the limitations for storage and amounts required for reactor operation, as described in the Final Safety Analysis Report, as supplemented and amended;

   C. Pursuant to the Act and 10 CFR Parts 30, 40, and 70 to receive, possess, and use at any time any byproduct, source and special nuclear material as sealed neutron sources for reactor startup, sealed sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts as required;

   D. Pursuant to the Act and 10 CFR Part 30 to receive, possess, and use at any time 100 millicuries each of any byproduct material without restriction to chemical or physical form, for sample analysis or instrument calibration or associated with radioactively contaminated apparatus;

   E. Pursuant to the Act and 10 CFR Parts 40 and 70 to receive, possess, and use at any time 100 milligrams each of any source or special nuclear material without restriction to chemical or physical form, for sample analysis or instrument calibration or associated with radioactively contaminated apparatus;

   F. Pursuant to the Act and 10 CFR Parts 30 and 70, to possess, but not separate, such byproduct and special nuclear materials as may be produced by the operation of Turkey Point Units Nos. 3 and 4.

3. This subsequent renewed operating license shall be deemed to contain and is subject to the conditions specified in the following Commission regulations: 10 CFR Part 20, Section 30.34 of 10 CFR Part 30, Section 40.41 of 10 CFR Part 40, Sections 50.54 and 50.59 of 10 CFR Part 50, and Section 70.32 of 10 CFR Part 70; and is subject to all

applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect, and is subject to the additional conditions specified below:

A. Maximum Power Level

The applicant is authorized to operate the facility at reactor core power levels not in excess of 2644 megawatts (thermal).

B. Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment No. 292, are hereby incorporated into this subsequent renewed license. The Environmental Protection Plan contained in Appendix B is hereby incorporated into this subsequent renewed operating license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

C. Final Safety Analysis Report

The licensee's Final Safety Analysis Report supplement submitted pursuant to 10 CFR 54.21(d), as revised on November 1, 2001, describes certain future inspection activities to be completed before the period of extended operation. The licensee shall complete these activities no later than July 19, 2012.

The Final Safety Analysis Report supplement as revised on November 1, 2001, described above, shall be included in the next scheduled update to the Final Safety Analysis Report required by 10 CFR 50.71(e)(4), following the issuance of this renewed license. Until that update is complete, the licensee may make changes to the programs described in such supplement without prior Commission approval, provided that the licensee evaluates each such change pursuant to the criteria set forth in 10 CFR 50.59 and otherwise complies with the requirements in that section.

D. Fire Protection

FPL shall implement and maintain in effect all provisions of the approved fire protection program that comply with 10 CFR 50.48(a) and 10 CFR 50.48(c), as specified in the licensee amendment requests dated June 28, 2012 and October 17, 2018 (and supplements dated September 19, 2012; March 18, April 16, and May 15, 2013; January 7, April 4, June 6, July 18, September 12, November 5, and December 2, 2014; and February 18, 2015; October 24, and December 3, 2018; and January 31, 2019), and as approved in the safety evaluations dated May 28, 2015 and March 27, 2019. Except where NRC approval for changes or deviations is required by 10 CFR 50.48(c), and provided no other regulation, technical specification, license condition or requirement would require prior NRC approval, the licensee may make changes to the fire protection program without prior approval of the Commission if those changes satisfy the provisions set forth in 10 CFR 50.48(a) and 10 CFR 50.48(c), the change does not require a change to a technical specification or a license condition, and the criteria listed below are satisfied.

Risk-Informed Changes that May Be Made Without Prior NRC Approval

A risk assessment of the change must demonstrate that the acceptance criteria below are met. The risk assessment approach, methods, and data shall be acceptable to the NRC and shall be appropriate for the nature and scope of the change being evaluated; be based on the as-built, as-operated, and maintained plant; and reflect the operating experience at the plant. Acceptable methods to assess the risk of the change may include methods that have been used in the peer-reviewed fire PRA model, methods that have been approved by NRC through a plant-specific license amendment or NRC approval of generic methods specifically for use in NFPA 805 risk assessments, or methods that have been demonstrated to bound the risk impact.

(a) Prior NRC review and approval is not required for changes that clearly result in a decrease in risk. The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins. The change may be implemented following completion of the plant change evaluation.

(b) Prior NRC review and approval is not required for individual changes that result in a risk increase less than $1x10^{-7}$/year (yr) for CDF and less than 1×10^{-8}/yr for LERF. The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins. The change may be implemented following completion of the plant change evaluation.

Other Changes that May Be Made Without Prior NRC Approval

1. Changes to NFPA 805, Chapter 3, Fundamental Fire Protection Program

Prior NRC review and approval are not required for changes to the NFPA 805, Chapter 3, fundamental fire protection program elements and design requirements for which an engineering evaluation demonstrates that the alternative to the Chapter 3 element is functionally equivalent or adequate for the hazard. The licensee may use an engineering evaluation to demonstrate that a change to an NFPA 805, Chapter 3, element is functionally equivalent to the corresponding technical requirement. A qualified fire protection engineer shall perform the engineering evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement, using a relevant technical requirement or standard.

The licensee may use an engineering evaluation to demonstrate that changes to certain NFPA 805, Chapter 3, elements are acceptable because the alternative is "adequate for the hazard." Prior NRC review and approval would not be required for alternatives to four specific sections of NFPA 805, Chapter 3, for which an engineering evaluation demonstrates that the alternative to the Chapter 3 element is adequate for the hazard. A qualified fire protection engineer shall perform the engineering evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement, using a relevant technical requirement or standard. The four specific sections of NFPA 805, Chapter 3, are as follows:

- "Fire Alarm and Detection Systems" (Section 3.8);
- "Automatic and Manual Water-Based Fire Suppression Systems" (Section 3.9);
- "Gaseous Fire Suppression Systems" (Section 3.10); and
- "Passive Fire Protection Features" (Section 3.11).

This License Condition does not apply to any demonstration of equivalency under Section 1.7 of NFPA 805.

2. Fire Protection Program Changes that Have No More than Minimal Risk Impact

Prior NRC review and approval are not required for changes to the licensee's fire protection program that have been demonstrated to have no more than a minimal risk impact. The licensee may use its screening process as approved in the NRC safety evaluation dated May 28, 2015, to determine that certain fire protection program changes meet the minimal criterion. The licensee shall ensure that fire protection defense-in-depth and safety margins are maintained when changes are made to the fire protection program.

<u>Transition License Conditions</u>

1. Before achieving full compliance with 10 CFR 50.48(c), as specified by 2. and 3. below, risk-informed changes to the licensee's fire protection program may not be made without prior NRC review and approval unless the change has been demonstrated to have no more than a minimal risk impact, as described in 2. above.

2. The licensee shall implement the modifications to its facility, as described in Enclosure 1, Attachment S, Table S-2, "Plant Modifications Committed," of FPL letter L-2014-303, dated 11/05/2014, to complete the transition to full compliance with 10 CFR 50.48(c) by the end of the second refueling outage (for each unit) following issuance of the license amendment. The licensee shall maintain appropriate compensatory measures in place until completion of these modifications.

3. The licensee shall implement the items listed in Enclosure 5, Attachment S, Table S-3, "Implementation Items," of FPL letter L-2018-219, dated 12/3/2018, with the exception of items 12, 18 and 19, no later than 12 months after issuance of the license amendment dated 5/28/2015. Items 12, 18 and 19 are associated with modifications in Table S-2 and will be completed in accordance with Transition License Condition 2 above.

E. The licensee shall fully implement and maintain in effect all provisions of the Commission-approved physical security, training and qualification, and safeguards contingency plans including amendments made pursuant to provision of the Miscellaneous Amendments and Search Requirements revisions to 10 CFR 73.55 (51 FR 27817 and 27822) and to the authority of 10 CFR 50.90 and 10 CFR 50.54(p). The combined set of plans, which contains Safeguards Information protected under 10 CFR 73.21, is entitled: "Florida Power and Light Turkey Point Nuclear Plant Physical Security Plan, Training and Qualification Plan, Safeguards Contingency Plan, and Independent Spent Fuel Storage Installation Security Program - Revision 15" submitted by letter dated August 3, 2012.

The licensee shall fully implement and maintain in effect all provisions of the Commission-approved cyber security plan (CSP), including changes made pursuant to the authority of 10 CFR 50.90 and 10 CFR 50.54(p). The Turkey Point Nuclear Generating Station CSP was approved by License Amendment No. 245 as supplemented by a change approved by Amendment Nos. 256 and 266.

F. 1. The licensee shall restrict the combined number of fuel assemblies loaded in the existing spent fuel pool storage racks and cask pit rack to no more than the capacity of the spent fuel pool storage racks. This condition applies at all times, except during activities associated with a reactor core offload/reload refueling condition. This restriction will ensure the capability to unload and remove the cask pit rack when cask loading operations are necessary.

2. The licensee shall establish two hold points within the rack installation procedure to ensure proper orientation of the cask rack in each unit's spent fuel pool. Verification of proper cask pit rack orientation will be implemented by an authorized Quality Control inspector during installation of the racks to ensure consistency with associated spent fuel pool criticality analysis assumptions.

G. Mitigation Strategy License Condition

Develop and maintain strategies for addressing large fires and explosions and that include the following key areas:

(a) Fire fighting response strategy with the following elements:

1. Pre-defined coordinated fire response strategy and guidance
2. Assessment of mutual aid fire fighting assets
3. Designated staging areas for equipment and materials
4. Command and control
5. Training of response personnel

(b) Operations to mitigate fuel damage considering the following

1. Protection and use of personnel assets
2. Communications
3. Minimizing fire spread
4. Procedures for implementing integrated fire response strategy
5. Identification of readily-available pre-staged equipment
6. Training on integrated fire response strategy
7. Spent fuel pool mitigation measures

(c) Actions to minimize release to include consideration of:

1. Water spray scrubbing
2. Dose to onsite responders

H. PAD TCD Safety Analyses

1. PAD 4.0 TCD has been specifically approved for use for the Turkey Point licensing basis analyses. Upon NRC's approval of a revised generic version of PAD that accounts for Thermal Conductivity Degradation (TCD), FPL will within six months:

   a. Demonstrate that PAD 4.0 TCD remains conservatively bounding in licensing basis analyses when compared to the new generically approved version of PAD w/TCD, or
   b. Provide a schedule for the re-analysis using the new generically approved version of PAD w/TCD for any of the affected licensing basis analyses

I. FPL is authorized to implement the Risk Informed Completion Time Program as approved in License Amendment No. 284 subject to the following conditions:

1. FPL will complete the items listed in the table of implementation items in the enclosure to FPL letter L-2018-118 dated June 12, 2018 prior to implementation of the Risk Informed Completion Time Program.

2. The risk assessment approach and methods, shall be acceptable to the NRC, be based on the as-built, as-operated, and maintained plant, and reflect the operating experience of the plant as specified in RG 1.200. Methods to assess the risk from extending the completion times must be PRA methods accepted as part of this license amendment, or other methods approved by the NRC for generic use. If the licensee wishes to change its methods, and the change is outside the bounds of this license condition, the licensee will seek prior NRC approval via a license amendment.

J. Subsequent License Renewal License Conditions

1. The information in the Final Safety Analysis Report (FSAR) supplement submitted pursuant to 10 CFR 54.21(d), as revised during the subsequent license renewal application review process, and FPL commitments as listed in Appendix A of the "Safety Evaluation Report Related to the Subsequent License Renewal of Turkey Point Generating Units 3 and 4," dated July 22, 2019, are collectively the "Subsequent License Renewal FSAR Supplement." This Supplement is henceforth part of the FSAR, which will be updated in accordance with 10 CFR 50.71(e). As such, FPL may make changes to the programs, activities, and commitments described in the Subsequent License Renewal FSAR Supplement, provided FPL evaluates such changes pursuant to the criteria set forth in 10 CFR 50.59, "Changes, Tests, and Experiments," and otherwise complies with the requirements in that section.

2. The Subsequent License Renewal FSAR Supplement, as defined in renewed license condition (J)(1) above, describes programs to be implemented and activities to be completed prior to the subsequent period of extended operation, which is the period following the July 19, 2032, expiration of the initial renewed license.

   a. FPL shall implement those new programs and enhancements to existing programs no later than 6 months before the subsequent period of extended operation.

   b. FPL shall complete those activities by the 6-month date prior to the subsequent period of extended operation or by the end of the last refueling outage before the subsequent period of extended operation, whichever occurs later.

   c. FPL shall notify the NRC in writing within 30 days after having accomplished item (2)(a) above and include the status of those activities that have been or remain to be completed in item (2)(b) above.

3. FPL shall complete the replacement of a portion of the existing containment spray system carbon steel piping with stainless steel piping by December 1, 2024, so that any remaining carbon steel piping will not normally be internally exposed to borated water during the subsequent period of extended operation. The scope of replacement is the carbon steel piping from the stainless steel to the carbon steel dissimilar metal weld for the two containment

spray piping headers (3A and 3B) at penetrations P-19A and P-19B to a minimum plant elevation of 65 feet inside containment. FPL shall notify the NRC in writing within 60 days following completion of the refueling outage during which the piping replacement is completed. The notification will confirm the elevation of the air-to-borated-water interface inside the piping and confirm that the installation of the stainless steel piping exceeds this elevation.

4. This subsequent renewed license is effective as of the date of issuance, and shall expire at midnight July 19, 2052.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Ho K. Nieh, Director
Office of Nuclear Reactor Regulation

Attachments:
Appendix A - Technical Specifications for Unit 3
Appendix B - Environmental Protection Plan

Date of Issuance: December 4, 2019

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

FLORIDA POWER & LIGHT COMPANY

DOCKET NO. 50-251

TURKEY POINT NUCLEAR GENERATING UNIT NO. 4

SUBSEQUENT RENEWED FACILITY OPERATING LICENSE NO. DPR-41

The U.S. Nuclear Regulatory Commission (the Commission) having previously made the findings set forth in Renewed License No. DPR-41 issued on June 6, 2002, has now found that:

a. The application for Subsequent Renewed Facility Operating License No. DPR-41 filed by Florida Power and Light Company, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I and all required notifications to other agencies or bodies have been duly made;

b. Actions have been identified and have been or will be taken with respect to (1) managing the effects of aging during the subsequent period of extended operation on the functionality of structures and components that have been identified to require review under 10 CFR 54.21(a)(1), and (2) time-limited aging analyses that have been identified to require review under 10 CFR 54.21(c), such that there is reasonable assurance that the activities authorized by this subsequent renewed operating license will continue to be conducted in accordance with the current licensing basis, as defined in 10 CFR 54.3, for the Turkey Point Unit 4 plant, and that any changes made to the plant's current licensing basis in order to comply with 10 CFR 54.29(a) are in accord with the Act and the Commission's regulations;

c. The facility will operate in conformity with the application, as amended, the provisions of the Act, and the rules and regulations of the Commission;

d. There is reasonable assurance (i) that the facility can be operated at steady state power levels up to 2644 megawatts thermal in accordance with this subsequent renewed operating license without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the rules and regulations of the Commission;

e. Florida Power and Light Company is technically and financially qualified to engage in the activities authorized by this subsequent renewed operating license in accordance with the rules and regulations of the Commission;

f. The applicable provisions of 10 CFR Part 140 have been satisfied;

g. The subsequent renewal of this renewed operating license will not be inimical to the common defense and security or to the health and safety of the public; and

h. After weighing the environmental, economic, technical and other benefits of the facility against environmental costs and considering available alternatives, the issuance of Subsequent Renewed Facility Operating License No. DPR-41 is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

On the basis of the foregoing findings regarding this facility, Renewed Facility Operating License No. DPR-41, issued on June 6, 2002, is superseded by Subsequent Renewed Facility Operating License No. DPR-41, which is hereby issued to Florida Power and Light Company (FPL), to read as follows:

1. This subsequent renewed operating license applies to the Turkey Point Nuclear Generating Unit No. 4 nuclear power reactor, a pressurized, light water moderated and cooled reactor, and associated steam generators and electrical generating equipment (the facility). The facility is located on the applicant's Turkey Point site in Miami-Dade County, about 25 miles south of Miami, Florida, and is described in the Final Safety Analysis Report as supplemented and amended, and the Environmental Report as supplemented and amended.

2. Subject to the conditions and requirements incorporated herein, the Commission hereby licenses FPL:

   A. Pursuant to Section 104b of the Atomic Energy Act of 1954, as amended (the Act), and 10 CFR Part 50, "Licensing of Production and Utilization Facilities," to possess, use, and operate the facility as a utilization facility at the designated location on the Turkey Point site, in accordance with the procedures and limitations set forth in this subsequent renewed operating license;

   B. Pursuant to the Act and 10 CFR Part 70, to receive, possess, and use at any time special nuclear material as reactor fuel, in accordance with the limitations for storage and amounts required for reactor operation, as described in the Final Safety Analysis Report, as supplemented and amended;

   C. Pursuant to the Act and 10 CFR Parts 30, 40, and 70 to receive, possess, and use at any time any byproduct, source and special nuclear material as sealed neutron sources for reactor startup, sealed sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts as required;

   D. Pursuant to the Act and 10 CFR Part 30 to receive, possess, and use at any time 100 millicuries each of any byproduct material without restriction to chemical or physical form, for sample analysis or instrument calibration or associated with radioactively contaminated apparatus;

   E. Pursuant to the Act and 10 CFR Parts 40 and 70 to receive, possess, and use at any time 100 milligrams each of any source or special nuclear material without restriction to chemical or physical form, for sample analysis or instrument calibration or associated with radioactively contaminated apparatus;

   F. Pursuant to the Act and 10 CFR Parts 30 and 70, to possess, but not separate, such byproduct and special nuclear materials as may be produced by the operation of Turkey Point Units Nos. 3 and 4.

3. This subsequent renewed operating license shall be deemed to contain and is subject to the conditions specified in the following Commission regulations: 10 CFR Part 20, Section 30.34 of 10 CFR Part 30, Section 40.41 of 10 CFR Part 40, Sections 50.54 and 50.59 of 10 CFR Part 50, and Section 70.32 of 10 CFR Part 70; and is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect, and is subject to the additional conditions specified below:

A. Maximum Power Level

The applicant is authorized to operate the facility at reactor core power levels not in excess of 2644 megawatts (thermal).

B. Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment No. 282, are hereby incorporated into this subsequent renewed operating license. The Environmental Protection Plan contained in Appendix B is hereby incorporated into this subsequent renewed license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

C. Final Safety Analysis Report

The licensee's Final Safety Analysis Report supplement submitted pursuant to 10 CFR 54.21(d), as revised on November 1, 2001, describes certain future inspection activities to be completed before the period of extended operation. The licensee shall complete these activities no later than April 10, 2013.

The Final Safety Analysis Report supplement as revised on November 1, 2001, described above, shall be included in the next scheduled update to the Final Safety Analysis Report required by 10 CFR 50.71(e)(4), following the issuance of this renewed license. Until that update is complete, the licensee may make changes to the programs described in such supplement without prior Commission approval, provided that the licensee evaluates each such change pursuant to the criteria set forth in 10 CFR 50.59 and otherwise complies with the requirements in that section.

D. Fire Protection

FPL shall implement and maintain in effect all provisions of the approved fire protection program that comply with 10 CFR 50.48(a) and 10 CFR 50.48(c), as specified in the licensee amendment requests dated June 28, 2012 and October 17, 2018 (and supplements dated September 19, 2012; March 18, April 16, and May 15, 2013; January 7, April 4, June 6, July 18, September 12, November 5, and December 2, 2014; and February 18, 2015; October 24, and December 3, 2018; and January 31, 2019), and as approved in the safety evaluations dated May 28, 2015 and March 27, 2019. Except where NRC approval for changes or deviations is required by 10 CFR 50.48(c), and provided no other regulation, technical specification, license condition or requirement would require prior NRC approval, the licensee may make changes to the fire protection program without prior approval of the Commission if those changes satisfy the provisions set forth in 10 CFR 50.48(a) and 10 CFR 50.48(c), the change does not require a change to a technical specification or a license condition, and the criteria listed below are satisfied.

Risk-Informed Changes that May Be Made Without Prior NRC Approval

A risk assessment of the change must demonstrate that the acceptance criteria below are met. The risk assessment approach, methods, and data shall be acceptable to the NRC and shall be appropriate for the nature and scope of the change being evaluated; be based on the as-built, as-operated, and maintained plant; and reflect the operating experience at the plant. Acceptable methods to assess the risk of the change may include methods that have been used in the peer-reviewed fire PRA model, methods that have been approved by NRC through a plant-specific license amendment or NRC approval of generic methods specifically for use in NFPA 805 risk assessments, or methods that have been demonstrated to bound the risk impact.

(a) Prior NRC review and approval is not required for changes that clearly result in a decrease in risk. The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins. The change may be implemented following completion of the plant change evaluation.

(b) Prior NRC review and approval is not required for individual changes that result in a risk increase less than $1x10^{-7}$/year (yr) for CDF and less than 1×10^{-8}/yr for LERF. The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins. The change may be implemented following completion of the plant change evaluation.

<u>Other Changes that May Be Made Without Prior NRC Approval</u>

1. Changes to NFPA 805, Chapter 3, Fundamental Fire Protection Program

Prior NRC review and approval are not required for changes to the NFPA 805, Chapter 3, fundamental fire protection program elements and design requirements for which an engineering evaluation demonstrates that the alternative to the Chapter 3 element is functionally equivalent or adequate for the hazard. The licensee may use an engineering evaluation to demonstrate that a change to an NFPA 805, Chapter 3, element is functionally equivalent to the corresponding technical requirement. A qualified fire protection engineer shall perform the engineering evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement, using a relevant technical requirement or standard.

The licensee may use an engineering evaluation to demonstrate that changes to certain NFPA 805, Chapter 3, elements are acceptable because the alternative is "adequate for the hazard." Prior NRC review and approval would not be required for alternatives to four specific sections of NFPA 805, Chapter 3, for which an engineering evaluation demonstrates that the alternative to the Chapter 3 element is adequate for the hazard. A qualified fire protection engineer shall perform the engineering evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement, using a relevant technical requirement or standard. The four specific sections of NFPA 805, Chapter 3, are as follows:

- "Fire Alarm and Detection Systems" (Section 3.8);
- "Automatic and Manual Water-Based Fire Suppression Systems" (Section 3.9);
- "Gaseous Fire Suppression Systems" (Section 3.10); and
- "Passive Fire Protection Features" (Section 3.11).

This License Condition does not apply to any demonstration of equivalency under Section 1. 7 of NFPA 805.

2. Fire Protection Program Changes that Have No More than Minimal Risk Impact

Prior NRC review and approval are not required for changes to the licensee's fire protection program that have been demonstrated to have no more than a minimal risk impact. The licensee may use its screening process as approved in the NRC safety evaluation dated May 28, 2015, to determine that certain fire protection program changes meet the minimal criterion. The licensee shall ensure that fire protection defense-in-depth and safety margins are maintained when changes are made to the fire protection program.

Transition License Conditions

1. Before achieving full compliance with 10 CFR 50.48(c), as specified by 2. and 3. below, risk-informed changes to the licensee's fire protection program may not be made without prior NRC review and approval unless the change has been demonstrated to have no more than a minimal risk impact, as described in 2. above.

2. The licensee shall implement the modifications to its facility, as described in Enclosure 1, Attachment S, Table S-2, "Plant Modifications Committed," of FPL letter L-2014-303, dated 11/05/2014, to complete the transition to full compliance with 10 CFR 50.48(c) by the end of the second refueling outage (for each unit) following issuance of the license amendment. The licensee shall maintain appropriate compensatory measures in place until completion of these modifications.

3. The licensee shall implement the items listed in Enclosure 5, Attachment S, Table S-3, "Implementation Items," of FPL letter L-2018-219, dated 12/3/2018, with the exception of items 12, 18 and 19, no later than 12 months after issuance of the license amendment dated 5/28/2015. Items 12, 18 and 19 are associated with modifications in Table S-2 and will be completed in accordance with Transition License Condition 2 above.

E. The licensee shall fully implement and maintain in effect all provisions of the Commission-approved physical security, training and qualification, and safeguards contingency plans including amendments made pursuant to provision of the Miscellaneous Amendments and Search Requirements revisions to 10 CFR 73.55 (51 FR 27817 and 27822) and to the authority of 10 CFR 50.90 and 10 CFR 50.54(p). The combined set of plans, which contains Safeguards Information protected under 10 CFR 73.21, is entitled: "Florida Power and Light Turkey Point Nuclear Plant Physical Security Plan, Training and Qualification Plan, Safeguards Contingency Plan, and Independent Spent Fuel Storage Installation Security Program - Revision 15" submitted by letter dated August 3, 2012.

The licensee shall fully implement and maintain in effect all provisions of the Commission-approved cyber security plan (CSP), including changes made pursuant to the authority of 10 CFR 50.90 and 10 CFR 50.54(p). The Turkey Point Nuclear Generating Station CSP was approved by License Amendment No. 241 as supplemented by a change approved by Amendment Nos. 252 and 261.

F. 1. The licensee shall restrict the combined number of fuel assemblies loaded in the existing spent fuel pool storage racks and cask pit rack to no more than the capacity of the spent fuel pool storage racks. This condition applies at all times, except during activities associated with a reactor core offload/reload refueling condition. This restriction will ensure the capability to unload and remove the cask pit rack when cask loading operations are necessary.

2. The licensee shall establish two hold points within the rack installation procedure to ensure proper orientation of the cask rack in each unit's spent fuel pool. Verification of proper cask pit rack orientation will be implemented by an authorized Quality Control inspector during installation of the racks to ensure consistency with associated spent fuel pool criticality analysis assumptions.

G. Mitigation Strategy License Condition

Develop and maintain strategies for addressing large fires and explosions and that include the following key areas:

(a) Fire fighting response strategy with the following elements:

1. Pre-defined coordinated fire response strategy and guidance
2. Assessment of mutual aid fire fighting assets
3. Designated staging areas for equipment and materials
4. Command and control
5. Training of response personnel

(b) Operations to mitigate fuel damage considering the following

1. Protection and use of personnel assets
2. Communications
3. Minimizing fire spread
4. Procedures for implementing integrated fire response strategy
5. Identification of readily-available pre-staged equipment
6. Training on integrated fire response strategy
7. Spent fuel pool mitigation measures

(c) Actions to minimize release to include consideration of:

1. Water spray scrubbing
2. Dose to onsite responders

H. PAD TCD Safety Analyses

1. PAD 4.0 TCD has been specifically approved for use for the Turkey Point licensing basis analyses. Upon NRC's approval of a revised generic version of PAD that accounts for Thermal Conductivity Degradation (TCD), FPL will within six months:

   a. Demonstrate that PAD 4.0 TCD remains conservatively bounding in licensing basis analyses when compared to the new generically approved version of PAD w/TCD, or
   b. Provide a schedule for the re-analysis using the new generically approved version of PAD w/TCD for any of the affected licensing basis analyses

I. FPL is authorized to implement the Risk Informed Completion Time Program as approved in License Amendment No. 278 subject to the following conditions:

1. FPL will complete the items listed in the table of implementation items in the enclosure to FPL letter L-2018-118 dated June 12, 2018 prior to implementation of the Risk Informed Completion Time Program.

2. The risk assessment approach and methods, shall be acceptable to the NRC, be based on the as-built, as-operated, and maintained plant, and reflect the operating experience of the plant as specified in RG 1.200. Methods to assess the risk from extending the completion times must be PRA methods accepted as part of this license amendment, or other methods approved by the NRC for generic use. If the licensee wishes to change its methods, and the change is outside the bounds of this license condition, the licensee will seek prior NRC approval via a license amendment.

J. Subsequent License Renewal License Conditions

1. The information in the Final Safety Analysis Report (FSAR) supplement submitted pursuant to 10 CFR 54.21(d), as revised during the subsequent license renewal application review process, and FPL commitments as listed in Appendix A of the "Safety Evaluation Report Related to the Subsequent License Renewal of Turkey Point Generating Units 3 and 4," dated July 22, 2019, are collectively the "Subsequent License Renewal FSAR Supplement." This Supplement is henceforth part of the FSAR, which will be updated in accordance with 10 CFR 50.71(e). As such, FPL may make changes to the programs, activities, and commitments described in the Subsequent License Renewal FSAR Supplement, provided FPL evaluates such changes pursuant to the criteria set forth in 10 CFR 50.59, "Changes, Tests, and Experiments," and otherwise complies with the requirements in that section.

2. The Subsequent License Renewal FSAR Supplement, as defined in renewed license condition (J)(1) above, describes programs to be implemented and activities to be completed prior to the subsequent period of extended operation, which is the period following the April 10, 2033, expiration of the initial renewed license.

    a. FPL shall implement those new programs and enhancements to existing programs no later than 6 months before the subsequent period of extended operation.

    b. FPL shall complete those activities by the 6-month date prior to the subsequent period of extended operation or by the end of the last refueling outage before the subsequent period of extended operation, whichever occurs later.

    c. FPL shall notify the NRC in writing within 30 days after having accomplished item (2)(a) above and include the status of those activities that have been or remain to be completed in item (2)(b) above.

3. FPL shall complete the replacement of a portion of the existing containment spray system carbon steel piping with stainless steel piping by December 1, 2024, so that any remaining carbon steel piping will not normally be internally exposed to borated water during the subsequent period of extended operation. The scope of replacement is the carbon steel piping from the stainless steel to the carbon steel dissimilar metal weld for the two containment spray piping headers (4A and 4B) at penetrations P-19A and P-19B to a minimum plant elevation of 65 feet inside containment. FPL shall notify the NRC in writing within 60 days following completion of the refueling outage during which the piping replacement is completed. The notification will confirm the elevation of

the air-to-borated water interface inside the piping, and confirm that the installation of the stainless steel piping exceeds this elevation.

4. This subsequent renewed license is effective as of the date of issuance, and shall expire at midnight April 10, 2053.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Ho K. Nieh, Director
Office of Nuclear Reactor Regulation

Attachments:
Appendix A - Technical Specifications for Unit 4
Appendix B - Environmental Protection Plan

Date of Issuance: December 4, 2019

47016

Proposed Rules

Federal Register

Vol. 56, No. 180

Tuesday, September 17, 1991

NUCLEAR REGULATORY COMMISSION

10 CFR Part 51

RIN 3150-AD 94

Environmental Review for Renewal of Operating Licenses

AGENCY: Nuclear Regulatory Commission.

ACTION: Proposed rule.

SUMMARY: The Nuclear Regulatory Commission (NRC) is proposing to amend its regulations to establish new requirements for environmental review of applications to renew operating licenses for nuclear power plants. The proposed amendments would define the number and scope of environmental impacts that would need to be addressed as part of a license renewal application. Concurrent with the proposed amendments, the NRC is publishing for comment (1) a draft generic environmental impact statement, (2) a draft regulatory guide, (3) a draft environmental standard review plan, and (4) a draft regulatory analysis, which supplement the proposed amendments. A workshop on the proposed amendments and the draft generic environmental impact statement will be held during the comment period.

DATES: Comment period expires December 16, 1991. Comments received after this date will be considered if it is practical to do so, but the Commission is able to assure consideration only of comments received on or before this date. Notification of intent to attend the workshop, concurrent session preferences, and desire to participate as a panelist during a specific session should be received by the staff no later than October 4, 1991. Comments on the proposed agenda received by the staff by October 4, 1991, will be considered in developing the final workshop agenda. A final agenda and detailed information on each session will be available after October 18, 1991. This information will be mailed to all individuals and organizations who notify the NRC of their intent to attend and to others who request it. The workshop will be held on November 4 and 5, 1991.

ADDRESSES: Send comments to: The Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, DC 20555, Attention: Docketing and Services Branch, or hand deliver comments to the Office of the Secretary, One White Flint North, 11555 Rockville Pike, Rockville, Maryland between 7:30 a.m. and 4:15 p.m. on Federal workdays. Copies of comments received may be examined at the NRC Public Document Room, 2120 L Street NW., (Lower Level), Washington, DC between the hours of 7:45 a.m. and 4:15 p.m. on Federal workdays. The workshop will be held at the Rosslyn Westpark Hotel, 1900 North Fort Myer Drive, Arlington, Virginia 22209. Send notification of intent to attend and desire to participate as a panelist during a specific session to Donald Cleary, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

FOR FURTHER INFORMATION CONTACT: Donald Cleary, Division of Safety Issues Resolution, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, DC 20555, telephone (301) 492-3936.

SUPPLEMENTARY INFORMATION:

I. Introduction

The Commission is proposing to amend 10 CFR part 51 to improve the efficiency of the process of environmental review when an applicant seeks to renew an operating license for up to an additional 20 years. To prepare for possible license renewal applications, the Commission considered the merits of relying on the existing framework for environmental review in part 51 rather than revising part 51. In reaching its decision to revise part 51, the Commission considered the following factors: (1) License renewal will involve nuclear power plants for which the environmental impacts of operation are well understood as a result of data evaluated from operating experience to date; (2) activities and requirements associated with license renewal are anticipated to be within this range of operating experience, thus environmental impacts can reasonably be predicted; and (3) changes in the environment around nuclear power plants are generally gradual and predictable with respect to characteristics important to environmental impact analyses.

The Commission has conducted a study of the potential environmental impacts of license renewal. The objective of the study was to (1) identify all the potential impacts to the environmental and other National Environmental Policy Act (NEPA) issues associated with plant license renewal, (2) determine which of these environmental impacts and other NEPA issues could be evaluated generically for all plants, and (3) determine the significance of these issues that could be generically evaluated. The analyses and results of this study are presented in the draft Generic Environmental Impact Statement (GEIS) (NUREG-1437), which is being published for comment concurrently with this proposed rule. The staff concludes in the GEIS that only a limited number of the total potential impacts cannot be evaluated generically. Those impacts that cannot be evaluated generically will have to be evaluated for each plant before its license is renewed. However, the environmental impacts that can be generically evaluated will not have to be evaluated for each plant.

The GEIS provides the basis for this rulemaking. To develop the GEIS, the NRC staff followed the recommended procedures of the Council on Environmental Quality (CEQ), including scoping activities such as consulting the CEQ and other Federal agencies, a public workshop held on November 12–14, 1989 (54 FR 41980; October 13, 1989), and publication of a Notice of Intent to prepare the GEIS (55 FR 29967; July 23, 1990).

The proposed rule addresses the potential environmental impacts that are generically evaluated for all plants in the GEIS and codifies the findings in the GEIS. In addition, those potential impacts that are not generically evaluated in the GEIS are identified in the proposed rule to be evaluated on a plant-specific basis. By assessing and codifying certain potential environmental impacts on a generic basis, no need exists to address these impacts for each future license renewal. The proposed amendments should result in considerable savings to the NRC, the nuclear utility industry, and the nuclear utility ratepayers, while ensuring that the environmental impacts of license renewal are evaluated, as required by the NEPA.

The basic information and the supporting analysis of environmental impacts that serve as the basis of this proposed rulemaking are presented in the draft GEIS, NUREG–1437. The draft GEIS and these proposed amendments to 10 CFR part 51 also provide the basis for developing a license renewal draft supplement to Regulatory Guide 4.2, "Preparation of Environmental Reports for Nuclear Power Stations," which provides guidance on the format and content of the environmental report to be submitted as part of the license renewal application. Additionally, the staff also prepared a draft Environmental Standard Review Plan (NUREG–1429) to provide guidance to the staff on the scope of the review necessary to implement the proposed amendments to part 51.

II. Background

A. License Renewal—10 CFR Part 54

A significant number of the operating licenses for the existing nuclear power plants are due to expire in the early part of the 21st century. The NRC anticipates that a number of licensees will submit applications to renew an operating license 10 to 20 years before the license expires. The first of these applications is expected in the near future. The NRC has issued a proposed rule, 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants" (55 FR 29043; July 17, 1990), that would establish the requirements that an applicant must meet, the information that must be submitted to the NRC for review so that the agency can determine whether these requirements have in fact been met, and the application procedures. The proposed part 54 permits the renewal of an operating license for up to an additional 20-year increment beyond the expiration of its current license (initial licensee authorize 40 years of operation). The part 54 rule could be applied to multiple renewals of an operating license for various increments. However, the part 51 amendments apply to one renewal of the initial license for up to 20 years beyond the expiration of the initial license.

License renewal for each plant will be based on the current licensing basis (i.e., the original licensing basis for the plant as amended during the initial license term) and changes, as necessary, to address the effects of age-related degradation on systems, structures, and components important to license renewal. To comply with 10 CFR part 54, the licensee shall assess and determine those activities and modifications that are necessary, at the time of license renewal and throughout the renewal term, to ensure continued safe operation of the plant. Each licensee shall identify and incorporate those activities necessary for managing aging into its licensing basis, thereby ensuring that acceptable margins of safety are preserved throughout the license renewal term. In addition, each applicant for a license renewal shall submit an environmenal report that complies with the requirements of 10 CFR part 51, the NRC regulations governing environmental protection for domestic licensing.

B. Environmental Review

The scope of the NRC's National Environmental Policy Act (NEPA) review is found in 10 CFR part 51. To meet the provisions of 10 CFR 51.45, the applicant shall submit an environmental report (ER) that discusses (1) the impact of the proposed action on the environment, (2) any adverse environmental impacts that cannot be avoided, (3) alternatives to the proposed action, (4) the relationship between local short-term uses of the environment and maintenance and enhancement of long-term productivity, and (5) any irreversible or irretrievable commitments of resources. In addition, the licensee shall submit an analysis that considers and balances the environmental effects of the proposed action and the alternatives available for reducing or avoiding adverse environmental effects, as well as the benefits of the action. The NRC will independently review this material and publish the results.

Before issuing a construction permit (CP) or an operating license (OL) for a nuclear power plant, the NRC is required to assess the potential environmental impacts of the plant to ensure that the issuance of a permit or license is consistent with the NEPA and the NRC implementing regulations of the NEPA in 10 CFR part 51. For those plants licensed subsequent to the enactment of the NEPA, baseline quantitative studies and monitoring programs were often developed for comparison with data gathered from later programs if adverse effects of construction or operation were reasonably inferred from information obtained during the gathering of preconstruction or operational baseline phases. These studies were part of the applicant's environmental report and were reviewed in the staff's final environmental statement (FES) for the specific plant. These studies and programs were restricted to the impact assessment of important resources and important species described in the staff's guidance documents such as Regulatory Guide 4.2, and Environmental Standard Review Plans (NUREG–0555). The staff's final assessments of these programs were normally summarized in each plant-specific FES. On the basis of these reviews, appropriate environmental parameters would have been proposed for monitoring or for special studies.

Although two operating nuclear power plants were licensed before the NEPA was enacted and do not have FESs, the GEIS did consider and envelop these plants. Accordingly, the Commission believes that no reason exists to treat these two plants differently in the environmental review for each plant's license renewal.

Additionally, nonradiological discharges of pollutants to receiving waters from operating nuclear power plants that are licensed by the NRC are subject to limitations or monitoring under the Federal Water Pollution Control Act (FWPCA), administered by the U.S. Environmental Protection Agency (EPA) or designated State agencies. The resultant reporting requirements of a National Pollutant Discharge Elimination System (NPDES) permit are relied upon by the EPA and designated State agencies to provide data on potential problems. Permits are subject to review and approval every 5 years and may be modified by the permitting authority on the basis of an analysis of data generated from plant-specific NPDES monitoring programs.

The Commission considers that one of its responsibilities under the NEPA is to be cognizant of significant environmental impacts during the term of a plant's operations. For impacts involving degradation of the aquatic environment, the reporting requirements of an NPDES permit authorized by the FWPCA are generally relied upon to alert the NRC to potential problems. In addition, the Commission includes conditions in its licenses to protect the environment in accordance with 10 CFR 50.36(b). These conditions identify appropriate requirements for reporting and recording environmental data and for monitoring requirements to protect the nonaquatic environment under 10 CFR part 50, a license may also reference environmental protection plans, environmental technical specifications, and radiological technical specifications. Therefore, the environmental effect of current operating reactors is well known and the probable future effect if licenses are renewed can be predicted with some confidence. This practice is consistent with regulations promulgated by the CEQ that direct agencies to adopt monitoring and enforcement programs, where appropriate. As a result of the staff's environmental reviews, certain environmental conditions, including monitoring requirements, may be included in NRC licenses. Licensees submit the information from monitoring of these conditions to the NRC on a routine basis, and the Commission responds as appropriate.

C. Use of Generic Rulemaking

The Commission has previously endorsed the generic rulemaking process and recognized the advantages of generic rulemaking. In an interim policy statement on generic rulemaking to improve nuclear power plant licensing, these advantages were identified:

(a) enhance stability and predictability of the licensing process by providing regulatory criteria and requirements in discrete generic areas on matters which are significant in the review and approval of license applications; (b) enhance public understanding and confidence in the integrity of the licensing process by bringing out for public participation important generic issues which are of concern to the agency and the public; (c) enhance administrative efficiency in licensing by removing, in whole or in part, generic issues from staff review and adjudicatory resolution in individual licensing proceedings and/or by establishing the importance (or lack of importance) of various safety and environmental issues to the decision process; (d) assist the Commission in resolving complex methodology and policy issues involved in recurring issues in the review and approval of individual licensing applications; and (e) yield an overall savings in the utilization of resources in the licensing process by the utility industry, those of the public whose interest may be affected by the rulemaking, the NRC and other Federal, State, and local governments with an expected improvement in the quality of the decision process.[1]

The NRC has used this generic approach in several part 51 rulemakings. Table S–4 of § 51.52 that gives the environmental impacts of the transportation of radioactive waste and nuclear fuel is an example. Applicants meeting certain criteria can use the information in Table S–4 as the basis for their evaluation of the environmental impacts of the transportation of radioactive waste and spent fuel. They are not required to conduct their own analysis of these impacts. Other examples of past generic part 51 rulemakings are Table S–3 of § 51.51 that gives the environmental impacts of the nuclear fuel cycle and § 51.53 and § 51.95, that eliminate the requirement to consider need for power and alternative energy sources for nuclear reactors at the operating license stage (47 FR 12940, March 26, 1982). Therefore, this rule is consistent with the NRC policy.

III. Proposed Action

A. Proposed Amendments

The proposed amendments to 10 CFR part 51 would establish new requirements for environmental review of an application to renew a license for a single plant. These amendments would require the applicant to address only those environmental issues that require a plant-specific assessment as part of an application for each plant. Applicants for all plants will have to assess environmental impacts on threatened and endangered species and impacts on local transportation during periods of refurbishment activities related to license renewal. These refurbishment activities are those activities that are planned for and performed on a nuclear power plant to prepare the plant for operation during the period the license is being renewed. These activities include equipment replacements, overhauls, maintenance, inspection, and testing. For other issues, all applicants either will have to demonstrate that their plants fall within defined bounds of plants for which a generic conclusion about an issue can be reached, or, if an issue does not fall within these bounds, assess that issue. Also, as part of its ER, an applicant will have to include an analysis of whether or not the findings of the assessment of each issue overturns the favorable cost-benefit balance for license renewal found in proposed appendix B to 10 CFR part 51.

The proposed amendments codify the conclusions of the GEIS for those issues for which a generic conclusion can be reached. The proposed appendix B, which summarizes the Commission's findings on the scope and magnitude of environmental and other effects of renewing the operating license of each nuclear power plant, is added to 10 CFR part 51. In the proposed appendix, the Commission also states its finding that the "renewal of any operating license for up to 20 years will have accrued benefits that outweigh the economic, environmental, and social costs of license renewal * * *."

In addition, the proposed amendments eliminate the requirement that the NRC staff must prepare a supplemental environmental impact statement (EIS) for every license renewal application; instead, the amendments permit the staff to prepare an environmental assessment (EA) if certain conditions are met. The basis for this proposed change is the GEIS finding that only a limited number of potential impacts need to be addressed to renew a license for each plant.

The Commission believes that, in many instances, this limited set of potential environmental issues will be found to have impacts that are nonexistent or small and, therefore, could be analyzed in an EA that results in a finding of no significant impact (FONSI). If no significant impacts are found in the EA, the NRC will issue a FONSI. If a FONSI cannot be made, the environmental review process would require developing a draft EIS for public comment and a final supplemental EIS. The supplemental EIS would evaluate the environmental impacts identified in the EA and their effect on the overall cost-benefit balance. The NRC will issue a supplemental EIS if any of the issues addressed are determined to have impacts that are negative and either moderate or large, as the terms are defined in proposed Appendix B of Subpart A of Part 51. Impacts that otherwise might be considered moderate could be mitigated to small by commitments made in a license renewal application.

The proposed amendments would define those environmental issues that need to be addressed in an application to renew a license for a single plant. The Commission wishes to emphasize the importance of the public commenting at this time on environmental reviews in the GEIS and the findings in the proposed rule. After the final rule is published, comment on environmental impacts of a licensing renewal action for a plant will be limited to those impacts

[1] Generic Rulemaking To Improve Nuclear Power Plant Licensing, Interim Policy Statement, 43 FR 58377; December 14, 1978.

that the rule requires to have a plant-specific evaluation.

However, the adoption of the proposed amendments would not preclude reopening environmental issues if significant new information becomes available. A petition to amend 10 CFR part 51 will be acted upon if new information warrants a reopening of issues. The Commission plans to periodically review the GEIS findings contained in appendix B to part 51 and its supporting documentation.

Environmental Impacts To Be Reviewed To Renew a License for Each Plant

The Commission concludes that the adverse environmental impacts of license renewal are minor compared to the benefits to be gained from continued operation for up to an additional 20 years beyond the initial license period. However, the proposed amendments require that each applicant address in its ER those environmental issues for which no generic conclusion can be reached.

The NRC staff, in its GEIS, divided its conclusions about environmental impacts into three categories and further drew a conclusion about the significance of each impact.

The NRC drew one of the following three conclusions about each impact:

Category 1. The NRC reached a conclusion about this impact that applies to all affected plants.

Category 2. The NRC reached a conclusion about this impact that applies to all affected plants that are within certain bounds.

Category 3. The NRC reached a conclusion about this impact that the licensee shall evaluate this impact for each plant for which it applies to renew a license.

The NRC then determined whether the significance of an impact about which it had drawn one of these three conclusions is "small," "moderate,"or "large."

• A small impact is so minor that it warrants neither detailed investigation nor consideration of mitigative actions when the impact is negative.

• A moderate impact is usually evident and usually warrants consideration of mitigation alternatives when the impact is negative.

• A large impact involves either a severe penalty or a major benefit and mitigation alternatives are always considered when an impact is negative.

The following includes 2 Category 3 issues and combines 22 Category 2 issues into 10 issues. The issues which must be addressed are as follows:

(1) The applicant must submit an assessment of potential impacts on threatened or endangered species.

(2) Aquatic impacts of entrainment, impingement, and heat shock are potential problems at plants with once-through or cooling-pond heat dissipation systems. However, plant operations and effluents that have the potential to cause these impacts are under the regulatory authority of EPA of State authorities. The permit process authorized by the FWPCA is an adequate mechanism for control and mitigation of these potential aquatic impacts. If an applicant to renew a license has appropriate EPA or State permits, further NRC review of these potential impacts is not warranted. Therefore, the proposed rule requires an applicant to provide the NRC with certification that it holds FWPCA permits, or if State regulation applies, current State permits. If the applicant does not so certify, it must assess these aquatic impacts.

(3) Potential aquatic impacts from any refurbishment activities would be minor or insignificant if best management practices are used to control soil erosion or spills. The proposed rule requires applicants to submit evidence of a construction impact control program.

(4) For plants located at inland sites and using cooling ponds, the applicant must assess groundwater quality impacts.

(5) For plants using Ranney wells or pumping 100 or more gallons per minute and having wells in the cone of depression, the applicant must assess groundwater-use conflicts.

(6) For potential terrestrial impacts, the NRC staff, in the GEIS, concluded that the only potential impact that need be evaluated to renew a license for each plant was any potential impact on important plant and animal habitats. These could include wetlands, wildlife concentration areas, and certain plant life environments. The proposed rule requires applicants to assess any potential impacts on such plant and animal habitats if construction activities generated by refurbishment or extended operation could affect these resources.

(7) The proposed amendments required any license renewal applicant, whose site does not have access to a low-level radioactive waste disposal facility, to assess environmental impacts of low-level waste management.

(8) Each applicant must verify that adequate provisions have been taken to ensure that transmission line electric shock effects are not a health hazard. The applicant may rely on National Electric Safety Codes for this assessment.

(9) An applicant with a plant at a site in a low-population area, as defined by numerical criteria on population and distance from sizable cities or in areas where growth control measures are in effect, must access housing impacts.

(10) For socioeconomic impacts, all applicants must assess potential transportation impacts during refurbishment.

(11) Applicants with plants using cooling ponds, lakes, or canals, or discharging cooling water to small rivers must address effects of microbiological organisms on human health.

(12) Applicants who exceed threshold criteria for cost of refurbishment, operating and maintenance, and fuel costs must submit a cost analysis to demonstrate the cost advantages of license renewal over the most reasonable replacement alternative. Applicants must also assess for certain plants the geothermal alternative.

B. Generic Environmental Impact Statement

The GEIS establishes the bounds and significance of potential environmental impacts at all 118 light-water nuclear power reactors currently licensed to operate or expected to be licensed to operate in the United States (113 nuclear power plants were licensed to operate as of June 30, 1992, plus Bellefonte Units 1 and 2, Comanche Peak Unit 2, and Watts Bar Units 1 and 2). For the GEIS, the NRC staff assessed all environmental issues that may be of concern to the NRC in its reviews of applications to renew operating licenses at these 118 nuclear power plants. The scope of these issues reflects the potential effects of plant refurbishment activities associated with license renewal, an additional 20 years of plant operation, and possible change in the plant environmental setting. For this analysis, all of the environmental issues identified were combined into 104 issues. For each type of environmental impact, the staff attempts to establish generic findings encompassing as many nuclear power plants as possible. Plant- and site-specific information is used in developing these generic findings. In conjunction with the proposed rule change, this GEIS also provides an applicant seeking to renew an operating license information and analyses that it may reference in the application. Further guidance on the format, content, and analysis standards for environmental documentation in their application is provided in draft Regulatory Guide 4.2, Supplement 1.

The analytical approach to assessing environmental impacts in this GEIS involves four stages:

(1) Characterize each issue on the basis of information from past plant construction and current operating experience to establish a baseline.

(2) Assess the extent to which activities and requirements associated with license renewal may differ from the baseline.

(3) Assess potential relevant changes in the environment and estimate trends for the technology and economics of alternative energy sources.

(4) Combine these separate analyses to fully characterize the nature and magnitude of impacts and other issues that will result from the refurbishments necessary for license renewal and the potential environmental impacts of operating plants for 20 years beyond their current 40-year licensing limit.

The upper bound scenario of refurbishment activities and plant operation that may be brought about by license renewal is described in detail in appendix B to the GEIS. All plants are considered enveloped by appendix B to the GEIS. The range of environmental issues considered in the GEIS was identified from past studies of nuclear power plant construction and operation (principally EISs), consultations with Federal and State regulatory agencies, and input from the nuclear utility industry and the general public.

The analyses in the GEIS drew on an extensive body of published materials from government, industry, academia, and other sources about operation and maintenance of nuclear power plants and their effects on the environment. Additional plant-specific information not otherwise available was collected by the Nuclear Utilities Management and Resources Council (NUMARC) and made available to Oak Ridge National Laboratory (ORNL) for use in the report. This information is available in the NRC Public Document Room. A team of environmental specialists from ORNL interviewed Federal, State, and local regulatory officials, as well as persons from business and other private organizations in the vicinity of nuclear power plants, as part of the effort to establish the scope for the GEIS.

The objectives of the GEIS are to (1) provide an understanding of the types and severity of environmental impacts that may occur as a result of renewing operating licenses for nuclear power plants, (2) identify and assess those impacts expected to be generic to license renewal, and (3) define the issues that need to be addressed by the NRC and the applicants in plant-specific license renewal proceedings.

The broad topical areas covered are surface-water quality, aquatic ecology, groundwater, terrestrial ecology, human health, socioeconomics, postulated accidents, waste management, decommissioning, need for generating capacity, and alternatives to license renewal.

In the GEIS, the NRC staff identified and evaluated the significance of the environmental impact of each of 104 environmental issues associated with the renewal of individual plant licenses. For 80 issues, the staff reached a generic conclusion that the potential environmental impacts are acceptable. For 22 issues, this conclusion could be reached for some subset of all nuclear power plants that were within bounds defined in the GEIS. For 2 issues, the staff concluded that no generic conclusion on impacts could be reached.

The Commission is proposing to limit the scope of environmental review for each plant license renewal to only those impacts for which no generic conclusion could be reached (i.e., Categories 2 and 3). All applicants will be required to provide appropriate information and analyses in their license renewal applications for all Category 2 and 3 impacts identified in the GEIS.

An evaluation of the impacts that have been assessed on a generic basis is summarized in a proposed new appendix B to part 51.

The NRC's NEPA review procedures in part 51 require "a preliminary analysis which considers and balances the environmental and other effects of the proposed action and the alternatives available for reducing or avoiding adverse environmental and other effects, as well as the environmental, economic, technical, and other benefits of the proposed action" (§ 51.71(d)). This analysis is found in chapter 10 of the GEIS. Table 10.1, "Summary of Conclusions on NEPA Issues" in the GEIS is included in these proposed amendments as proposed Table B.1 of appendix B of subpart A of part 51. The table lists each environmental issue addressed in the GEIS, states the conclusions, and includes an assessment of the benefit or cost involved. The major benefit is the electric energy that would be produced by a plant whose license is renewed. The major economic costs are those for refurbishing and for operating and maintaining a plant during the renewal term of up to 20 years. For those adverse environmental impacts that can be assessed generically (Category 1 and, for a subset of plants, Category 2), the adverse impact is identified as small. For environmental impacts for which generic conclusions can be reached, Table B–1 shows that no adverse environmental impacts exist that would offset the benefits of license renewal.

The other NEPA review requirements in 10 CFR part 51 that have been codified in Table B–1 are a review of short- and long-term benefits and productivity and irreversible commitments of resources. The principal short-term benefit from continued operation of nuclear plants is the production of electrical energy from an existing capital asset.

The Commission finds that the resource commitments involved in license renewal do not differ from resource commitments required during the initial operating license term. However, additional nuclear fuel will be used, and small amounts of materials will be used for plant refurbishment. A minor amount of additional land would be used.

Summary of Issues Analyzed in the GEIS

The following describes those environmental issues that were examined for the GEIS, and summarizes the conclusions by major topical area.

1. Surface Water Quality

For the GEIS, the NRC staff examined water quality, water-use conflicts, altered salinity gradients, altered current patterns, temperature effects on sediment transport, altered thermal stratification, scouring caused by discharged cooling water, eutrophication, discharge of chlorine or other biocides or chemical contaminants, and discharge of sanitary wastes.

Aquatic impacts from plant refurbishment activities to support license renewal could occur at any type of plant if erosion or spills occur. In the GEIS, the staff concluded that "best management practices" need to be used during refurbishment to prevent adverse impacts. Site-specific mitigation measures can be implemented during refurbishment to prevent or minimize construction-related aquatic impacts from erosion or spills. These impacts are normally of limited duration and affect only a portion of the aquatic environment. Potential impacts on threatened or endangered species cannot be assessed generically and will require plant-specific analysis.

2. Aquatic Ecology

For the GEIS, the staff examined impingement and entrainment, heat shock, cold shock, thermal plume barriers to migration, premature emergence of aquatic insects, stimulation of nuisance organisms, gas supersaturation, low dissolved oxygen in the discharge, accumulation of contaminants in sediment or biota, and losses from predators, parasites, and disease.

For nuclear power plants using once-through cooling systems, the operational experience of existing plants indicates that many early concerns about aquatic resources have not materialized. Neither the published literature nor the responses of regulatory and resource agencies have revealed potential concerns about such early issues as phytoplankton and zooplankton entrainment and premature emergence of aquatic insects in thermal discharges. Although significant localized effects of these stresses have occasionally been demonstrated, the populations' rapid regeneration and biological compensatory mechanisms are sufficient to preclude long-term or far-field impacts.

However, some issues involving aquatic resources warranted further monitoring, and in some cases, mitigative measures to define and correct adverse impacts. The entrainment and impingement of fish and the discharge of large volumes of heated effluents into small or warm ambient waters were a source of concern at some nuclear power plants. These issues were examined and resolved through the mechanisms of NPDES permits and associated FWPCA 316(a) and (b) determinations and were either found to be acceptable or actions were implemented to mitigate the problems. For a few plants, the NPDES process has not been completed and the issues relating impingement, entrainment, and thermal discharges have not all been resolved. For these plants, issues relating to intake and discharge effects on fish and shellfish may be unresolved.

Resource agencies are expending major efforts to restore anadromous fish runs, particularly salmon and American shad, through water quality improvements, stocking, and removal of migration barriers. As a result, a number of the agencies have expressed concerns about future impingement and entrainment impacts at plants that operate on certain rivers. These concerns are routinely addressed during the NPDES permit renewal process. Nuclear power plants with once-through cooling systems that currently discharge cooling water near the upper temperature limits of their NPDES permits may find complying with those requirements increasingly difficult if climates change and ambient water temperatures warm in the coming decades. Under these conditions, such plants may need to modify their operations during the warmest months or rely more on helper cooling towers to prevent adverse thermal impacts. Continuing to consult resource agencies and permitting agencies and to promptly resolve NPDES permit issues are expected to ensure that future changes in the environment do not lead to unacceptable impacts on aquatic ecology.

3. Groundwater Use and Quality

For the GEIS, the NRC staff examined groundwater use and quality; groundwater-use conflicts, including use of Ranney wells; and groundwater quality degradation and concluded that ground-water use conflicts and quality degradation may be a problem at certain plants. Groundwater quality at some river sites may be degraded by induced infiltration of poor-quality river water into an aquifer that supplies large quantities of plant cooling water.

Sites with closed-cycle cooling ponds may degrade groundwater quality. For those plants located inland, the quality of groundwater in the vicinity of ponds must be shown to remain within the State regulatory agency's defined-use category.

4. Terrestrial Ecology

For the GEIS, the NRC staff examined refurbishment impacts, cooling tower impacts on crops and native plants, bird collisions with cooling towers and transmission lines, cooling-pond impacts, power line right-of-way management, electromagnetic field effects, and effects on floodplains and wetlands, threatened or endangered species, air quality, and land use.

Refurbishment activities would disturb only small areas of land and should result in no significant loss of terrestrial habitats. Air quality impacts from refurbishment are not expected to lead to significant environmental impact. Salt draft from cooling towers at nuclear plants has not been shown to threaten agricultural crops, orchards, or other cultivated vegetation. Cooling tower operation has not been reported to reduce crops yields except in situations where crops were experimentally placed next to cooling towers. No significant adverse impacts of transmission lines and their maintenance was identified. Potential refurbishment impacts that will require an analysis for each plant would be those that may occur if one or more important terrestrial resources (wetlands, endangered species) would be affected.

5. Public Health

For the GEIS, the NRC staff examined radiation exposures to the public, occupational radiation exposures from refurbishment and extended operation, acute and chronic health effects of the electromagnetic fields of transmission lines, microbiological organisms associated with the cooling system known as the ultimate heat sink and noise.

For the GEIS, the staff assessed public health impacts from refurbishment activities and extended operation. Occupational exposure and doses to the public are expected to remain well within regulatory limits. The 9 plants using cooling ponds, lakes, or canals and the 14 plants discharging to small rivers have the potential to influence thermophilic organisms. Health questions related to public use of affected waters need to be addressed by utilities for each plant license renewal. The potential for electrical shock-induced currents from transmission lines should be reviewed with respect to the National Electric Safety Code (NESC) recommendations. Biological and physical studies of 60-Hz electromagnetic fields have not demonstrated consistent evidence linking harmful effects with field exposures.

6. Socioeconomics

For the GEIS, the staff assessed impacts in the following socioeconomic areas: housing, taxes, public services (excluding transportation), transportation, offsite land use, economic structure, and historic and aesthetic resources. They examined impacts from refurbishment activities as well as extended operation of nuclear power plants and reached generic conclusions for taxes, public services, excluding transportation, offsite land use, transportation impacts during continued operation, economic structure, and historic and aesthetic resources. These impacts may be either positive (taxes, employment, income) or negative, but small, and thus need not be addressed for each plant.

Housing impacts during refurbishment could be negative and potentially significant (moderate or large impact) for plants located in areas categorized as "low" population or as those that have growth control measures to limit housing development. In particular circumstances, transportation impacts during refurbishment could also be negative and significant. As a result, only housing and transportation issues need to be evaluated for each plant.

7. Uranium Fuel Cycle

For the GEIS, the NRC staff assessed the impacts of the uranium fuel cycle, which is based on the values given in 10 CFR 51.51 Table S–3, and analyzed the radiological impact from radon-222 and technetium-99. Categories of natural resource use that were analyzed include land use, water consumption and thermal effluents, radioactive releases, burial of transuranic and high- and low-level wastes, and radiation doses from transportation and occupational exposures. Radiological and nonradiological impacts were found to be small.

8. Waste Management

For the GEIS, the NRC staff examined the potential environmental impacts from the generation of various types of wastes during refurbishment and extended operation for an additional 20 years. More specifically, the staff examined nonradiological waste, mixed waste, low-level radiological waste storage and disposal, spent fuel storage and disposal, and transportation.

In the GEIS, the staff concluded that license renewal would have only minor impacts on mixed waste and nonradiological waste management activities. For low-level radioactive waste, onsite storage was judged to be adequate as suitable land is available at all plants for interim storage of additional waste from refurbishment and extended plant operation if disposal sites continue to accept waste in normal increments. The conclusions regarding low-level radioactive waste disposal hinge on the timely implementation of present plans for siting regional compact and individual State disposal sites. If circumstances change and the GEIS assumptions are no longer valid, these impacts would need to be addressed for each plant.

The greater volume of spent fuel resulting from up to 20 years of operation beyond the 40-year license can be safely accommodated onsite through dry or pool storage at all plants. The staff concluded that radioactive waste transportation impacts were small and bounded by the values in 10 CFR 51.52, Table S–4.

9. Postulated Accidents

For Chapter 5 of the GEIS, the NRC staff evaluated the environmental impacts of postulated accidents for the license renewal period. This evaluation included severe accidents as well as design-basis accidents. For design-basis accidents, all plants have had a previous evaluation of their environmental impacts. In addition, the licensees will be required to maintain acceptable design and performance criteria throughout the plant license renewal period. The calculated releases from design-basis accidents would not be expected to change. Therefore, the NRC staff concluded that the design of the plants associated with impacts from design-basis accidents remains acceptable. Severe accident environmental impacts were not evaluated in the past for all plants. However, since 1981, all plant FESs have included an analysis of severe accidents. In addition, in the past 10 years, extensive work has taken place on severe accident analysis and safety issue resolution. Therefore, the severe accident analyses done previously in support of FESs (a total of 27 FESs contain analyses of severe accidents) plus the results of other severe accident analyses done in the past were utilized and extrapolated to predict the severe accident environmental impacts for all plants at the midpoint of their license renewal period. For this assessment, the staff evaluted the environmental impacts of releases of radioactive materials to the atmosphere and groundwater as well as fallout over land and water. In addition, they evaluated the economic consequences of such accidents and the need to evaluate severe accident mitigation design alternatives (SAMDAs).

In the GEIS, the staff concluded that the environmental impacts of severe accidents during the license renewal period represent a low risk to the population and environment. Although the offsite consequences are potentially large, they are of low likelihood. Because of the low likelihood, the staff concluded that these impacts need not be considered further for each plant license renewal application. In addition to the low risk, Commission policy is to consider SAMDAs only at the initial construction stage (during which plant design features may be more easily incorporated). Accordingly, SAMDA evaluations at the license renewal stage are not necessary.

10. Decommissioning

For the GEIS, the staff examined radiation doses, waste management, air quality, water quality, ecological resources, economic impacts, and socioeconomic impacts.

The physical requirements and attendant effects of decommissioning nuclear power plants after a 20-year license renewal period are not expected to be different from those of decommissioning at the end of the current 40-year license period. Decommissioning after a 20-year license renewal period would increase the occupational dose by about 0.5 person-rem and the public dose by a negligible amount. License renewal would not increase the quantity or classification of low-level radioactive waste generated by decommissioning to any appreciable extent. Air and water quality and ecological impacts of decommissioning would not change as a result of license renewal.

Considerable uncertainty exists about the cost of decommissioning. While license renewal would not be expected to change the ultimate cost of decommissioning, it would reduce the present value of the cost. The socioeconomic effects of decommissioning will depend on the magnitude of the decommissioning effort, the size of the community, and other economic activities at the time. However, the NRC does not expect that the impacts would be increased by decommissioning at the end of a 20-year license renewal period rather than at the end of the current license term. Because the NRC can reach a generic conclusion on the acceptability of the incremental impacts of decommissioning for all plants, impacts on decommissioning need not be evaluated for each plant license renewal application.

11. Need for Generating Capacity

Projections of the demand for electric power from 1991 to 2030 in each of the 11 Department of Energy regions indicate that a need will exist for the generating capacity represented by license renewal of plants in all 11 regions. The projection included demands for both individual and utility service areas, which showed that the generating capacity of each nuclear power plant would be needed to meet the nation's electric power demand.

12. Alternatives to License Renewal

In chapter 8 of the GEIS, the staff established the need for the electric-generating capacity represented by the renewal of operating licenses. Chapter 9 of the GEIS addresses how the demand for this generating capacity could be filled by alternatives to license renewal and weighed the alternatives against that of license renewal.

In the GEIS, the staff concluded that new fossil-fuel and nuclear power plants are reasonable alternatives for replacing of retired nuclear capacity because they are proven commercial power-generating technologies, they can provide the baseload capacity currently generated by large nuclear units, and they are available nationwide. However, on balance, none of these alternatives offer significant environmental advantages over license renewal. In fact, license renewal of existing nuclear generating capacity would delay or eliminate the environmental impacts associated with constructing replacement power plants. The principal issues associated with operation of new fossil plants are emissions of pollutants. This includes SO_x, NO_x, and CO_x which contribute to the degradation of air quality, including acid rain and decreased visibility, and increase the potential for global warming and climate change. Although license renewal is expected to be more advantageous than new fossil or new nuclear plants from a cost perspective in most situations, a decision to seek license renewal is a prerogative of individual utilities. For the GEIS, the staff evaluated several studies and developed an independent estimate. Each study focused on comparing the costs of license renewal and new coal-generated capacity. From this comparison, the staff concluded that license renewal offers significant savings under a diverse set of conditions over new coal-generated capacity. However, differences in operating parameters and performance of nuclear plants would affect the actual cost savings for each plant.

With respect to renewable energy sources, the staff finds that wind, sun, water, and biomass are not preferred near-term alternatives to license renewal because of technological limitations (nonbaseload power sources), availability, and economics. The potential exists for small-scale regional application of geothermal energy to replace a small fraction of current nuclear baseload capacity.

Therefore, in the GEIS, the staff concludes, for the nation as a whole, license renewal is preferable to replacing the generating capacity with a new facility. Because some uncertainty is associated with the economic costs of license renewal caused by the plant-specific nature of the refurbishment required, a limited data submittal including analysis of cost of refurbishment, should accompany each license renewal application. If these data meet the threshold criterion, no analysis of alternatives need accompanying the license application. If the submittal shows that license renewal cannot meet the threshold criterion, the applicant should submit an analysis of the most reasonable alternative. In addition, licensees for plants in California, Oregon, Washington, or Arizona should submit a cost comparison of license renewal to geothermal energy.

C. Regulatory Guidance To Support the 10 CFR Part 51 Revisions

To ensure proper implementation of the revised sections of 10 CFR part 51, the NRC is issuing a draft regulatory guide and a draft environmental standard review plan for license renewal. Both documents are being published concurrently with these proposed amendments. The draft guide, identified as Draft Supplement 1 to Regulatory Guide 4.2, establishes a uniform format and content acceptable to the staff for structuring and presenting the environmental information to be compiled and submitted by an applicant to renew an operating license. More specifically, this draft regulatory guide describes the content of environmental information to be included in a license renewal application, including the criteria to address appropriate Category 2 issues as specified in the proposed amendments to 10 CFR part 51.

Draft "Environmental Standard Review Plan for License Renewal" (ESRP–LR) NUREG–1429 provides guidance for the NRC staff when performing a 10 CFR part 51 environmental review of an application to renew an operating license. The plan parallels Regulatory Guide 4.2, Supplement 1. The primary purpose of the ESRP–LR is to ensure that these reviews are focused on those environmental concerns associated with license renewal as described in 10 CFR part 51. Specifically, it provides guidance to the NRC staff about environmental issues that should be reviewed and provides acceptance criteria to help the reviewer evaluate the information submitted as part of the license renewal appliation. It is also the intent of this plan to make information about the regulatory process available and to improve communication between the NRC, interested members of the public, and the nuclear power industry, thereby increasing understanding of the review process.

D. Public Comments on Advance Notice of Proposed Rulemaking

On July 23, 1990, the NRC published in the **Federal Register** an advance notice of proposed rulemaking (ANPR) (55 FR 29964) and a companion notice of intent to prepare a generic environmental impact statement (55 FR 29967). Advice and recommendations on the proposed rulemaking were invited from all interested persons. Comments were requested on nine specific questions. Comment were received from 29 groups and individuals. Two private individuals were opposed to the rulemaking. Of five citizens groups; one supported, three supported with qualifications, and one opposed the rulemaking. Of the two State agencies responding, one supported the rulemaking and one supported it with qualifications. Three Federal agencies supported the rulemaking with qualifications. All 16 NRC nuclear power plant licensees commenting on the ANPR supported the rulemaking. The one industry group that submitted comments supported the rulemaking. A summary of comments on each question and the staff response are as follows:

Question No. 1. Is a generic environmental impact statement or an environmental assessment required by the NEPA to support this propoed rulemaking or can the rulemaking be supported by a technical study?

Comments: Strong support for a generic environmental survey (GES) rather than a full GEIS to provide the technical basis for the rulemaking was expressed by the NUMARC, nuclear utilities, the U.S. Department of Energy, and Americans for Nuclear Energy, Inc. The EPA and the State of Wisconsin Public Service Commission (WPSC) support development of a comprehensive GEIS. Other comments offered no specific opinion on a GEIS versus a generic environmental survey. Supporters of the generic environmental survey approach stated that it is legally acceptable and would be less costly and less subject to delays. Supporters of a comprehensive GEIS believed that it is a feasible approach and a prudent one.

NRC Response: The NRC believes that while the GES provides an alternative approach to rulemaking, the GEIS approach is preferable and has been used to develop the proposed rule. The purpose of this rulemaking is to resolve as many National Environmental Policy Act (NEPA) issues as possible before beginning plant-by-plant license renewal reviews. Although the NRC recognized the possibility that not all NEPA issues would be fully resolvable in the GEIS, the NRC did not wish to make *a priori* judgments about which issues could be resolved generically and which could not. Also, even though some issues may not be fully resolved generically, the analyses performed for the GEIS have helped sharpen and focus the issues that must be addressed in specific license renewal reviews. To these ends the NEPA procedures specified in 10 CFR part 51 and followed in developing the GEIS do have the advantage of resulting in a comprehensive GEIS and rule that have been extensively reviewed by multiple outside, interested parties and therefore, will be stronger in focusing and limiting environmental discussion during license renewal.

In addition, a GES need not follow NEPA-mandated public comment requirements. It is envisioned as a scientific document, whose contents are similar in some ways to a GEIS, but it is published in final form without public comment. However, a GES need discuss neither alternatives to license renewal nor the cost-benefit balance of the major federal action (license renewal) under discussion. Therefore, use of a GES as support for limiting environmental discussion a license renewal hearings would weaken this rulemaking endeavor because of the lack of public participation in commenting on this cornerstone document and lack of compliance with the full-disclosure provision of NEPA.

Question No. 2. What alternative forms of codifying the findings of the generic environmental impact statement should be considered?

Comments: This question was not specifically addressed by most commenters. The NUMARC recommended that the findings of the GEIS be codified by classifying potential environmental impacts of license renewal into four categories that it described.

NRC Response: The NRC believes that the categories used in the GEIS and the results of the evaluation in chapter 10 of the GEIS permit codification of findings that is at least as adequate as would result from the NUMARC recommendation. The approach taken in the proposed rulemaking to codify the results of the GEIS is a mix of the four approaches identified in the ANPR.

Question No. 3. What activities associated with license renewal will lead to environmental impacts?

Comments: Several respondents addressed this question in general terms. NUMARC stated: "In general, most of the activities associated with license renewal that may have environmental impacts are the same activities considered in environmental evaluations for the initial licenses." Activities associated with license renewal are more fully discussed in a document that NUMARC submitted with its comments. The document is "Study of Generic Environmental Issues Related to License Renewal," dated May 9, 1989. A State agency identified a number of replacement activities that would result in generating low-level radioactive waste and radiation doses to workers engaged in these activities.

NRC Response: In May 1989, NUMARC submitted a study to the NRC in the context of the rulemaking on 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." Information on plant modification and operation activities associated with license renewal in this document was reviewed and considered in preparing the GEIS. Activities associated with license renewal that were identified by the State agency are addressed in the GEIS in chapter 2 and appendix B.

Question No. 4. What topical areas should be covered in the generic environmental impact statements? Should the proposed outline be supplemented or restructured?

Comments: Respondents to this question identified priority topics that should be covered in the GEIS and commented on the completeness of the scope of these topics. Those addressing the scope of such topics generally were satisfied with the list in the ANPR. Most concerns were with the balance of the treatment of topics within the outline. NUMARC, supported by member utilities, believed that some topics such as plant modifications associated with license renewal and decommissioning are unduly emphasized by being given major section status. A number of respondents discussed topical areas already identified in the ANPR about which they were particularly concerned. Several topics not identified in the ANPR were identified as concerns by one or more respondents. Concern was expressed that the pool of trained nuclear engineers is diminishing. Thus, operators may be less well qualified in the future. A respondent stated that each type of reactor should be treated separately. A Federal agency stated that the GEIS could assess the utilities' efforts to comply with the Public Utilities Regulatory Policy Act (PURPA) for financial assistance to private cogeneration facilities and that it could also assess the utilities' efforts to comply with State and local conservation efforts.

The WPSC raised the following four points not explicitly covered in the ANPR:

(1) Regarding the need for generating capacity, whether the NRC should defer to the relevant State agency's determination of need for generating capacity;

(2) Whether an accident that has the potential for leading to a demand by the public that all reactors be shut down could jeopardize the supply of electricity;

(3) Whether plant management history will be considered in a license renewal decision; and

(4) Whether embrittlement of the reactor pressure vessel may result in shutting plants down for susceptibility to pressurized thermal shock soon after extending the license.

NRC Response: The NRC believes that the scope of the GEIS accommodates most of the issues of concern raised in the comments. However some issues raised are beyond the scope of the GEIS. The NRC will ensure the qualification of operators in the future through NRC regulations, especially 10 CFR Part 55, "Operator's Licenses". The NRC has not explicitly assessed compliance with PURPA and State and local conservation efforts on a utility-by-utility basis and it does not believe it is necessary to do so. Conservation and cogeneration projections are already incorporated in forecasts of need for generating capacity.

Regarding WPSC's comment that the NRC should defer to the determination of need that relevant State agencies made, the NRC encourages State agencies to review analyses in the GEIS for consistency with their own analyses and to comment on any significant disagreements between them. Regarding the concern about a possible public demand to shut down all reactors after a severe accident at one, the NRC assumes in the GEIS that the programs described in Chapter 5 of the GEIS will maintain a low probability of a severe accident and that a shutdown of all reactors is speculative. Management history is not an issue that is addressed in the GEIS or the proposed rule. Although management action will be continually monitored through the operating life of any plant, it will not be a major topic evaluated to renew a license. The NRC will consider the embrittlement status of the reactor pressure vessel for a license renewal, and its status may indeed limit the term or bar the issuance of a renewed license.

Question No. 5. For each topical area, what are the specific environmental issues that should be addressed?

Comments: NUMARC was the only respondent who specifically addressed this question. Several other respondents did identify specific topics and environmental issues that concerned them. These other responses are addressed under Question No. 4. NUMARC referred the NRC to the detailed areas treated in the NUMARC report titled "Study of Generic Environmental Issues Related to License Renewal," dated May 9, 1989, and submitted to the NRC in May 1989.

NRC Response: The NUMARC report has been reviewed and was considered in developing the scope and analyses of the GEIS.

Question No. 6. For each topical area and each specific issue, what information and data are required to perform generic analyses? Where do the information and data exist?

Comments: NUMARC referred to its study submitted to the NRC titled, "Study of Generic Environmental Issues Related to License Renewal," and point out that the study contains relevant information and an extensive list of data sources. The EPA offered to provide information about the effect of electromagnetic frequency radiation and global climate change. The WPSC stated that information about the need for power, the amount of conservation that is technically and economically possible, and load management exists at each utility and at the corresponding State utility commission.

NRC Response: All information in the NUMARC study was reviewed and was used as appropriate in developing the GEIS. The NRC considered the EPA's information and guidance on effects of electromagnetic frequency radiation and global climate change. In the GEIS, the NRC took a regional generic approach about the need for power, conservation, and load management. The NRC believes this is an adequate analysis to establish the need for generating capacity for each plant but is requesting comment on its analysis.

Question No. 7. For each topical area and each specific issue, what criteria should be used to judge the significance of the environmental impact?

Comments: This question was specifically addressed by NUMARC and Yankee Atomic Electric Company. NUMARC provided the more detailed response, and it was consistent with the Yankee Atomic response. NUMARC made a number of general observations about the significance criteria embodied in the NRC practice in the environmental and associated safety areas and in the CEQ guidelines. They provided examples of significant criteria for endangered species, impacts to aquatic biota, and radiological impacts.

NRC Response: These comments generally support the approach to determine the significance of environmental issues employed in the GEIS.

Question No. 8. For each topical area and each specific issue, what is the potential for successful analysis?

Comments: NUMARC addressed this question in detail. Commenting utilities supported the NUMARC response. Other responses ranged from a general statement that generic treatment is not feasible to a general statement that generic treatment is feasible. Several commenters each mentioned doubts about the possibility of generic treatment of at least some of the following: need for generating capacity, alternatives, climate change, impacts from refurbishment and continued operation, and severe accidents. NUMARC stated that "nearly all, if not all, of the impacts associated with license renewal have been found amenable to generic analysis." Using the four categories of generic conclusions (see Question No. 2), NUMARC presented conclusions on the categorization of various impacts from plant operation, plant modification, accidents, decommissioning, need for generating capacity, and alternative generating capacity.

NRC Response: The NRC considered the positions offered in comments on the potential of generic analysis for each topical area and each specific issue. The NRC findings are summarized in chapter 10 of the GEIS. The NRC believes that the approach taken in the GEIS resulted in generic conclusions that both encompass site- and region-specific considerations and consider forecasting uncertainties.

Question No. 9. What length of extended operating time can reasonably be addressed in the proposed rulemaking? To what extent is it possible to reach generic conclusions about the environmental impacts that would be applicable to plants having renewed operating licenses expiring in the year 2030, 2040, or 2050?

Comments: Several commenters had doubts about the accuracy of long-term forecasts of need for generating capacity, alternative energy sources, climate change, and severe accidents. NUMARC specifically addressed this question and pointed out that environmental impact evaluations are performed for new plants for 40 to 50 years into the future, but that unlike new plants, applicants who will apply for plant license renewal have an operating history with accumulated monitoring data. NUMARC also stated that the NRC has the option of revising the GEIS at any future time if experience shows an impact that deviates significantly from its predicted value.

NRC Response: The NRC agrees with NUMARC's observations and believes the conclusions reached in the GEIS issue reflect careful consideration of future uncertainties.

IV. Questions

Public comment on conclusions about potential environmental impacts is being solicited as part of this rulemaking. The Commission will evaluate comments on this notice and the draft GEIS before publishing a final rule.

In addition to general comments on the proposed rulemaking, the Commission is especially interested in public responses to the following questions:

(1) Should the NRC staff have the flexibility, as provided in the proposed rule, to choose to prepare an environmental assessment instead of a supplemental environmental impact statement for each plant license to be renewed? In answering this question, please consider whether it makes a difference if this proposed rulemaking is supported by a generic environmental survey rather than a full GEIS?

(2) For presenting a full discussion of environmental impacts from postulated accidents as required by the NEPA:

(a) Is the exposure index (EI) method, as used in chapter 5 of the GEIS to predict potential environmental impacts of atmospheric releases of radioactive material from a severe accident, sufficient to present for consideration the potential impacts from severe accident of atmospheric releases for all plants for the license renewal period? If not, what alternative analyses would be acceptable?

(b) Is the method of analysis of radionuclide deposition from fallout over open bodies of water from severe accidents of atmospheric releases, as used in chapter 5 of the GEIS, sufficient to present for consideration the potential impacts of atmospheric fallout for all plants? If not, what alternative analyses would be acceptable?

(c) Is the method of analysis of releases to groundwater from severe accidents, as used in chapter 5 of the GEIS, sufficient to present for consideration the potential impacts of releases to groundwater for all plants? If not, what alternative analyses would be acceptable?

(3) It is reasonable to conclude that, based upon the calculated low risk to the environment from severe accidents and the June 13, 1980, Commission Policy Statement on accident considerations under the NEPA (45 FR 40101), SAMDAs need not be considered in individual license renewal applications? If not, what alternative would be acceptable?

(4) What significant environmental issues, if any, have not been evaluated in the GEIS?

(5) Which evaluations presented, if any, are not sufficient for drawing generic conclusions?

(6) What additional analyses can be done to further address the Category 2 and 3 items? For example, what screening criteria could be applied to local transportation during

refurbishment and to threatened and endangered species to change these issues from Category 3 to Category 2? Are the criteria for meeting the defined bounding conditions for each of the Category 2 items sufficiently clear?

(7) The GEIS and this proposed action apply to all plants currently holding an OL or CP, except for Washington Nuclear Plant 1 and 3, Grand Gulf 2, and Perry 2. Should these plants be included in the scope of this action?

V. Availability of Documents

The principal supporting documents of this supplementary information are as follows:

(1) Draft Generic Environmental Impact Statement, NUREG–1437

(2) Draft Regulatory Analysis: Proposed Part 51 Amendments, NUREG–1440

(3) Draft Supplement to Regulatory Guide 4.2 (DG–4002)

(4) Draft Environmental Standard Review Plan—License Renewal, NUREG–1429

A free single copy of each of these documents, to the extent of supply, may be requested by those who are considering commenting by writing to the U.S. Nuclear Regulatory Commission, Washington, DC 20555 (ATTN: Distribution and Mail Services Section). Copies of all documents cited in the supplementary information are available for inspection and/or for copying for a fee, in the NRC Public Document Room, 2120 L St. NW. (Lower Level), Washington, DC.

In addition, copies of NRC documents cited here may be purchased from the Superintendent of Documents, U.S. Government Printing Office, PO Box 37082, Washington, DC 20013–7082. Copies are also available for purchase from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

VI. Workshop

A workshop is being scheduled during which experts with a diversity of perspectives can review the technical basis of the proposed amendments. Such interaction is expected to contribute information for the NRC to consider that may not otherwise have surfaced through written comments on the proposed amendments. In addition, the workshop may provide additional information that will assist those who comment in developing written comments.

The workshop is being designed to focus on the substantive technical findings of the GEIS codified in the proposed amendment. Workshop sessions will correspond to the major topical areas found in the GEIS and appendix B of subpart A of 10 CFR part 51. Workshop participants will be experts selected from industry, Federal and State agencies, and environmental organizations. Each workshop concurrent session will be limited to 15 participants and will be conducted in a panel format. Questions and statements from the audience will be taken if time permits.

Comments are invited on the following tentative agenda.

Day 1

7:45–8:30 Registration
8:30–8:45 Welcome
8:45–9:00 Workshop objectives, structure, ground rules
9:00–10:15 General Session—GEIS and proposed 10 CFR part 51 rulemaking overview
10:15–10:30 Break
10:30–11:45 General Session (cont.)
11:45–1:00 Lunch
1:00–3:00 *Concurrent Sessions*
A. Surface Water, Aquatic Ecology, Groundwater
B. Terrestrial Ecology, Land Use
C. Socioeconomics
3:00–3:15 Break
3:15–5:15 *Concurrent Sessions*
D. Decommissioning
E. Human Health
F. Need for Generating Capacity and Direct Economic Costs and Benefits

Day 2

8:30–10:15 *Concurrent Sessions*
G. Postulated Accidents
H. Solid Waste Management
I. Alternatives
10:15–10:30 Break
10:30–11:45 Concurrent Sessions G, H and I (cont.)
11:45–1:00 Lunch
1:00–2:00 General Session—NEPA Process
2:00–3:00 Summary and Conclusion of Sessions

VII. Submittal of Comments in an Electronic Format

Commenters are encouraged to submit, in addition to the original paper copy, a copy of their letter in an electronic format on IBM PC DOS-compatible 3.5- or 5.25-inch, double-sided, double-density (DS/DD) diskettes. Data files should be provided in Wordperfect 5.1. ASCII code is also acceptable or, if formatted text is required, data files should be provided in IBM Revisable-Form Text Document Content Architecture (RFT/DCA) format.

VIII. Environmental Impact: Categorical Exclusion

The NRC has determined that this proposed regulation is the type of action described in categorical exclusion 10 CFR 51.22(c)(3). Therefore neither an environmental impact statement nor an environmental assessment has been prepared for this proposed regulation. This action is procedural in nature in that it pertains to the type of environmental information to be reviewed.

IX. Paperwork Reduction Act Statement

This proposed rule amends information collection requirements that are subject to the Paperwork Reduction Act of 1980 (44 U.S.C. 3501 *et seq.*). This rule has been submitted to the Office of Management and Budget for review and approval of the paperwork requirements. Public reporting burden for this collection of information is estimated to average about 3000 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Information and Records Management Branch (MNBB–7714), U.S. Nuclear Regulatory Commission, Washington, DC 20555 and to the Desk Officer Office of Information and Regulatory Affairs, NEOB–3019 (3150–0021), Office of Management and Budget, Washington, DC 20503.

X. Regulatory Analysis

The Commission has prepared a draft regulatory analysis on this proposed regulation. The analysis examines the costs and benefits of the alternatives considered by the Commission. The two alternatives considered were (a) retaining the existing part 51 review process for license renewal, which requires that all review be done on a plant-specific basis, and (b) amending part 51 to allow a portion of the environmental review to be conducted on a generic basis. The conclusions of the draft regulatory analysis show substantial cost savings of alternative (b) over alternative (a).

The draft analysis is available for inspection in the NRC Public Document Room, 2120 L Street, NW. (Lower Level), Washington, DC. Copies of the analysis are available as described in Section V of this proposed rule. The Commission requests public comment on the draft regulatory analysis. Comments on the draft analysis may be submitted to the NRC as indicated under the addresses' heading.

XI. Regulatory Flexibility Act Certification

As required by the Regulatory Flexibility Act of 1980, 5 U.S.C. 605(b), the Commission certifies that this proposed rule will not have a significant impact on a substantial number of small entities. The proposed rule states application procedures and environmental information to be submitted by nuclear power plant licensees to facilitate the NRC's obligations under the NEPA. Nuclear power plant licensees do not fall within the definition of small businesses as defined in section 3 of the Small Business Act, 15 U.S.C. 632, the Small Business Size Standards of the Small Business Administrator (13 CFR part 121), or the Commission's Size Standards (50 FR 50241; December 9, 1985).

XII. Backfit Analysis

The rulemaking does not constitute a "backfit" as defined in 10 CFR 50.109(a)(1) and a backfit analysis need not be prepared. This rule addresses procedural requirements for considering the environmental effects of issuing a renewed operating license for a nuclear power plant. The Commission has not previously addressed these requirements either in rulemaking or in guidance documents. Moreover, policy considerations weigh against considering part 51 and its amendments as a "backfit." The primary impetus for the Backfit Rule was "regulatory stability," namely, that once the Commission decides to issue a license, the terms and conditions for operating under that license would not be arbitrarily changed *post hoc*. Regulatory stability is not a relevant issue with respect to license renewal. This rule has only a prospective effect upon nuclear power plant licensees. No licensee currently holds a renewed nuclear power plant operating license and therefore, no valid expectations could be changed regarding the terms and conditions for holding a renewed operating license.

List of Subjects in 10 CFR Part 51

Administrative practice and procedure, Environmental impact statement, Nuclear materials, Nuclear power plants and reactors, Reporting and recordkeeping requirements.

For the reasons set out in the preamble and under the authority of the Atomic Energy Act of 1954, as amended; the Energy Reorganization Act of 1974, as amended; the National Environmental Policy Act of 1969, as amended; and 5 U.S.C. 553; the NRC is proposing to adopt the following amendments to 10 CFR part 51.

PART 51—ENVIRONMENTAL PROTECTION REGULATIONS FOR DOMESTIC LICENSING AND RELATED REGULATORY FUNCTIONS

1. The authority citation for part 51 continues to read as follows:

Authority: Sec. 161, 68 Stat. 948, as amended (42 U.S.C. 2201); secs. 201, as amended, 202, 88 Stat. 1242, as amended, 1244 (42 U.S.C. 5841, 5842). Subpart A also issued under National Environmental Policy Act of 1969, secs. 102, 104, 105, 83 Stat. 853–854, as amended (42 U.S.C. 4332, 4334, 4335); and Pub. L. 95–604, Title II, 92 Stat. 3033–3041. Sections 51.20, 51.30, 51.60, 51.61, 51.80, and 51.97 also issued under secs. 135, 141, Pub. L. 97–425, 96 Stat. 2232, 2241, and sec. 148, Pub. L. 100–203, 101 Stat. 1330–223 (42 U.S.C. 10155, 10161, 10168). Section 51.22 also issued under sec. 274, 73 Stat. 688, as amended by 92 Stat. 3036–3038 (42 U.S.C. 2021) and under Nuclear Waste Policy Act of 1982, sec. 121, 96 Stat. 2228 (42 U.S.C. 10141). Sections 51.43, 51.67, and 51.109 also under Nuclear Waste Policy Act of 1982, sec. 114(f), 96 Stat. 2216, as amended (42 U.S.C. 10134(f)).

2. Section 51.20 is amended by revising paragraph (b)(2) to read as follows:

§ 51.20 Criteria for and identification of licensing and regulatory actions requiring environmental impact statements.

* * * * *

(b) * * *

(2) Issuance of a full-power or design-capacity license to operate a nuclear power reactor pursuant to part 50 of this chapter, or issuance or renewal of a full-power or design-capacity license to operate a testing facility or a fuel reprocessing plant pursuant to part 50 of this chapter.

* * * * *

2A. Footnotes 3 through 8 in part 51 are redesignated as footnotes 5 through 10.

3. Section 51.53 is revised to read as follows:

§ 51.53 Supplement to environmental report.

(a) *General.* Any supplement to an environmental report prepared under the provisions of this section may incorporate by reference any information contained in a prior environmental report or supplement thereto that relates to the same production or utilization facility or any information contained in a final environmental document previously prepared by the NRC staff that relates to the same production or utilization facility. Documents that may be referenced include, but are not limited to, the final environmental impact statement; supplements to the final environmental impact statement, including supplements prepared at the license renewal stage; environmental assessments and records of decisions prepared in connection with the construction permit, the operating license, and any license amendment for that facility.

(b) *Operating license stage.* Each applicant for a license to operate a production or utilization facility covered by § 51.20 shall submit with its application the number of copies, as specified in § 51.55, of a separate document, entitled "Supplement to Applicant's Environmental Report—Operating License Stage," which will update "Applicant's Environmental Report—Construction Permit Stage." Unless otherwise required by the Commission, the applicant for an operating license for a nuclear power plant shall submit this report only in connection with the first licensing action authorizing full-power operation. In this report, the applicant shall discuss the same matters described in §§ 51.45, 51.51, and 51.52, but only to the extent that they differ from those discussed or reflect new information in addition to that discussed in the final environmental impact statement prepared by the Commission in connection with the construction permit. Unless otherwise required by the Commission, no discussion of need for power or alternative energy sources or alternative sites for the facility or of any aspect of the storage of spent fuel for the facility within the scope of the generic determination in § 51.23(a) and in accordance with § 51.23(b) is required in this report.

(c) *Operating license renewal stage.* (1) Each applicant for renewal of a license to operate a nuclear power plant under part 54 of this chapter shall submit with its application the number of copies, as specified in § 51.55, of a separate document, entitled "Supplement to Applicant's Environmental Report—Operating License Renewal Stage."

(2) The supplemental report must contain a description of the proposed action, including the applicant's plans to modify the facility or its administrative control procedures as described in accordance with § 54.21(e) of this chapter. The report must describe in detail the modifications directly affecting the environment or affecting plant effluents that affect the environment.

(3) For those applicants seeking an initial renewal license and holding an operating license as of June 30, 1992, or

who hold an operating license for Bellefonte Unit 1 or 2, Comanche Peak Unit 2, or Watts Bar Unit 1 or 2, the scope of issues to be addressed in the supplemental report will be limited to the following:

(i) Unless otherwise required by the Commission, no discussion of license renewal issues identified as Category 1 issues in appendix B of subpart A of this part is required in the supplemental report.

(ii) For those issues identified as Category 2 in appendix B of subpart A of this part, the supplemental report must contain a demonstration that:

(A) The nuclear power plant uses only cooling towers for primary condenser cooling or that the license renewal applicant holds current Clean Water Act 316(b) determinations and if necessary a 316(a) variance in accordance with 40 CFR part 125, or equivalent State permits. If no such demonstration can be made, an assessment of the impact of the individual nuclear power plant license renewal on fish and shellfish resources resulting from heat shock and impingement and entrainment must be provided.

(B) The nuclear power plant is not located at an inland site or does not have cooling ponds. If no such demonstration can be made, an assessment of the impact of the individual nuclear power plant license renewal on groundwater quality must be provided.

(C) The nuclear power plant does not use Ranney wells and either does not pump 100 or more gallons per minute of groundwater or does not have private wells located within the cones of depression of the nuclear power plant wells. If no such demonstration can be made, an assessment of the impact of the individual nuclear power plant license renewal on groundwater-use conflicts must be provided.

(D) Construction activities that are related to license renewal that involve additional onsite land use will not affect important plant and animal habitats. If no such demonstration can be made, an assessment of the impact of the individual plant license renewal on important plant and animal habitats must be provided.

(E) No major construction activities associated with the nuclear power plant license renewal will take place at the site. If no such demonstration can be made, a construction impact control program that will mitigate potential impacts on the aquatic environment from soil erosion or spills must be implemented and a description of this program must be provided.

(F) The nuclear power plant is in a medium or high population area[3] and not in an area where growth-control measures that limit housing development are in effect. If no such demonstration can be made, an assessment of the impact of the individual nuclear power plant license renewal on housing availability must be provided.

(G) The design of the transmission lines of the nuclear power plant meets the recommendations of the National Electric Safety Code for preventing electric shock from induced currents. If no such demonstration can be made, an assessment of the impact of the individual nuclear power plant license renewal on the potential electric shock hazard from the transmission lines of the plant must be provided.

(H) The nuclear power plant does not use a cooling pond, lake, or canal and does not discharge water to a small river. If no such demonstration can be made, an assessment of the impact of thermophilic organisms in the affected water on the health of recreational users must be provided.

(I) The nuclear power plant will have access to a low-level radioactive waste disposal facility through a low-level waste compact or an unaffiliated State. If no such demonstration can be made, a presentation of capability and plans for interim waste storage must be provided with an assessment of potential ecological habitat destruction caused by construction activities.

(J) The replacement of equivalent generating capacity by a coal-fired plant has no demonstrated cost advantage[4] over the individual nuclear power plant license renewal. If no such demonstration can be made, a justification for choosing the license renewal alternative must be provided. For nuclear power plants located in California, Oregon, Washington, or Arizona, applicants to renew a license must also provide an assessment of geothermal generating capacity as an alternative to license renewal in addition to the cost demonstration results.

(iii) For those issues identified in Category 3 in appendix B of subpart A of this part, the supplemental report must contain an assessment about the following:

(A) The impact of renewing the license for the nuclear power plant on threatened or endangered species.

(B) The impact of renewing the license for the nuclear power plant on local transportation during periods of license-renewal-related refurbishment activities.

(4) The supplemental report must contain an analysis of whether the assessment required by paragraphs (c)(3)(ii)–(iii) of this section changes the findings documented in Table B–1 of appendix B of subpart A of this part that the renewal of any operating license for up to 20 years will have accrued benefits that outweigh the economic, environmental, and social costs of license renewal.

(d) *Postoperating license stage.* Each applicant for a license amendment authorizing the decommissioning of a production or utilization facility covered by § 51.20 and each applicant for a license or license amendment to store spent fuel at a nuclear power plant after expiration of the operating license for the nuclear power plant shall submit with its application the number of copies, as specified in § 51.55, of a separate document, entitled "Supplement to Applicant's Environmental Report—Post Operating License Stage," which will update "Supplement to Applicant's Environmental Report—Operating License Stage," and "Supplement to Applicant's Environmental Report—Operating License Renewal Stage," as appropriate, to reflect any new information or significant environmental change associated with the applicant's proposed decommissioning activities or with the applicant's proposed activities with respect to the planned storage of spent fuel. Unless otherwise required by the Commission, in accordance with the generic determination in § 51.23(a) and the provisions in § 51.23(b), the applicant shall only address the environmental impact of spent fuel storage for the term of the license applied for.

4. In § 51.55, paragraph (a) is revised to read as follows:

§ 51.55 Environmental report—number of copies; distribution.

(a) Each applicant for a license to construct and operate a production or utilization facility covered by paragraph (b)(1), (b)(2), (b)(3) or (b)(4) of § 51.20,

[3] An area is considered to have a medium or high population if any of the following conditions is satisfied:

(a) The plant is within 20 miles of a city of 25,000;

(b) The plant is within 50 miles of a city of 100,000;

(c) The population of the area within 20 miles of the plant is 75,000 or more;

(d) The population of the area within 50 miles of the plant is 1,500,000 or more; or

(e) The population of the area within 20 miles of the plant is 50,000 or more and, within 50 miles of the plant, the population is 400,000 or more.

[4] In performing the cost demonstration, costs of refurbishment, construction, fuel, operation, and maintenance must be considered.

each applicant for renewal of an operating license for a nuclear power plant, each applicant for a license amendment authorizing the decommissioning of a production or utilization facility covered by § 51.20, and each applicant for a license or license amendment to store spent fuel at a nuclear power plant after expiration of the operating license for the nuclear power plant shall submit to the Director of the Office of Nuclear Reactor Regulation or the Director of the Office of Nuclear Material Safety and Safeguards, as appropriate, 41 copies of an environmental report or any supplement to an environmental report. The applicant shall retain an additional 109 copies of the environmental report or any supplement to the environmental report for distribution to parties and Boards in the NRC proceedings; Federal, State, and local officials; and any affected Indian tribes; in accordance with written instructions issued by the Director of the Office of Nuclear Reactor Regulation or the Director of the Office Nuclear Material Safety and Safeguards, as appropriate.

* * * * *

5. Section 51.95 is revised to read as follows:

§ 51.95 Supplement to final environmental impact statement; environmental assessment.

(a) *General.* Any supplement to a final environmental impact statement or any environmental assessment prepared under the provisions of this section may incorporate by reference any information contained in a final environmental document previously prepared by the NRC staff that relates to the same production or utilization facility. Documents that may be referenced include, but are not limited to, the final environmental impact statement; supplements to the final environmental impact statement, including supplements prepared at the operating license stage; environmental assessments and records of decisions prepared in connection with the construction permit, the operating license, and any license amendment for that facility. A supplement to a final environmental impact statement will include a request for comments as provided in § 51.73.

(b) *Operating license stage.* In connection with the issuance of an operating license for a production or utilization facility, the NRC staff will prepare a supplement to the final environmental impact statement on the construction permit for that facility, which will update the prior environmental review. The supplement will only cover matters that differ from or that reflect significant new information concerning matters discussed in the final environmental impact statement. Unless otherwise determined by the Commission, a supplement on the operation of a nuclear power plant will not include a discussion of need for power or alternative energy sources or alternative sites or of any aspect of the storage of spent fuel for the nuclear power plant within the scope of the generic determination in § 51.23(a) and in accordance with § 51.23(b), and will only be prepared in connection with the first licensing action authorizing full-power operation.

(c) *Operating license renewal stage.* In connection with the renewal of an operating license for a nuclear power plant under part 54 of this chapter, the NRC staff will prepare an environmental assessment or, if warranted, a supplemental environmental impact statement. Unless otherwise determined by the Commission, the environmental assessment or the supplemental environmental impact statement will address only the matters in § 51.53(c) of this part. A supplemental environmental impact statement is required if significant impacts are found in the environmental assessment.

(d) *Postoperating license stage.* In connection with the amendment of an operating license to authorize the decommissioning of a production or utilization facility covered by § 51.20 or with the issuance, amendment, or renewal of a license to store spent fuel at a nuclear power plant after expiration of the operating license for the nuclear power plant, the NRC staff will prepare a supplemental environmental impact statement for the postoperating license stage or an environmental assessment, as appropriate, which will update the prior environmental review. Unless otherwise required by the Commission, in accordance with the generic determination in § 51.23(a) and the provisions of § 51.23(b), a supplemental environmental impact statement for the postoperating license stage or an environmental assessment, as appropriate, will address the environmental impacts of spent fuel storage only for the term of the license, license amendment, or license renewal applied for.

6. A new appendix B is added to subpart A, 10 CFR part 51 to read as follows:

Appendix B to Subpart A—Environmental Effect of Renewing the Operating License of a Nuclear Power Plant

The Commission has considered the environmental and other costs and benefits of alternatives to granting a renewed operating license for a nuclear power plant to a licensee who holds an operating license as of June 30, 1992, or who holds an operating license for Bellefonte Unit 1 or 2, Comanche Peak Unit 2, or Watts Bar Unit 1 or 2. The Commission has found that the renewal of any operating license for up to 20 years will have accrued benefits that outweigh the economic, environmental, and social costs of license renewal, subject to an evaluation of those issues identified as Category 2 (only for those nuclear power plants that are outside the envelope defined in each issue) and Category 3 in Table B-1. Table B-1 summarizes the Commission findings on the scope and magnitude of environmental and other effects of renewing the operating license for a nuclear power plant as required by section 102(2) of the National Environmental Policy Act of 1969, as amended. The Commission will periodically review the material in this appendix and update it if necessary.

TABLE B-1. SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS

Issue	Category[1]	Findings[2]
PART I. NEED FOR GENERATING CAPACITY		
Need for generating capacity via license renewal	1	LARGE BENEFIT. License renewal of an individual nuclear power plant will be needed to meet generating capacity requirements in the service area and to avoid constructing and operating new generating facilities which would otherwise be necessary to replace the retired nuclear plant.

TABLE B-1. SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS—Continued

Issue	Category[1]	Findings[2]
PART II. IMPACTS OF ALTERNATIVES		
Advances of alternatives to license renewal	1	NO ADVANTAGE. License renewal of an individual nuclear power plant is found to be preferable to replacement of the generating capacity with a new facility to the year 2020. License renewal is found to be preferable, both environmentally and economically[3] to either new fossil-fuel or new nuclear capacity. Wind, solar photovoltaic cells, solar thermal power, hydropower, and biomass are found to be not preferable to license renewal because of technological limitations, availability, and economics. Geothermal power could be competitive in areas where geothermal resources are readily available. These areas are in the states of California, Oregon, Washington, and Arizona.
PART III. BENEFITS/COST ASSESSMENT BENEFITS		
Direct Economic		
Generating capacity	1	LARGE BENEFIT. Will provide from 72 $\times$ 10³ to 1270 $\times$ 10³ net kW(e) reflecting the smallest to the largest plant.
Electric energy	1	LARGE BENEFIT. Will provide from 391 $\times$ 10⁶ to 6898 $\times$ 10⁶ kWh/yr reflecting the smallest to the largest plant.
Avoided costs	2[3]	SMALL TO LARGE BENEFIT. Compared to replacement of electric generating capacity with a new coal-fired plant, license renewal offers savings under a diverse set of conditions.
Indirect		
Local taxes Refurbishment	1	SMALL BENEFIT. Tax revenues will increase due to capital improvements.
Local taxes Renewal term	1	SMALL BENEFIT. The impact of tax revenues may vary from small to large depending on the total tax base of the taxing jurisdictions.
Employment Refurbishment	1	SMALL BENEFIT. Impacts on regional employment will be small to moderate depending on the total employment base of the region, and will be short-lived.
Employment Renewal term	1	SMALL BENEFIT. Impacts on regional employment will be small to large depending on the total employment base of the region.
COSTS Direct Economic[3]		
Refurbishment	2	MODERATE COST. Refurbishment costs will vary widely depending on specific plant requirements. In general, costs will be significantly lower relative to the capital cost of new coal-fired plants.
Fuel	2	SMALL COST. Fuel costs will be much lower than for a new coal-fired plant.
Operation and maintenance	2	LARGE COST. O&M costs will vary widely depending on specific plant performance but on the average they will be significantly more that for a new coal-fired plant.
Environmental and Socioeconomic Surface Water Quality, Hydrology, and Use (for all plants)		
Effects of refurbishment on surface-water quality	2	SMALL COST. Impacts are expected to be minor and insignificant during refurbishment if there are no major construction activities associated with the individual plant license renewal or if best management practices (BMPs) are employed to control soil erosion and spills; applicant must provide evidence of approved BMPs in license renewal application.
Effects of refurbishment on surface-water use	1	SMALL COST. Water use during refurbishment will not change or will be reduced during reactor outage.
Altered current patterns at intake and discharge structures	1	SMALL COST. Has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Altered salinity gradients	1	SMALL COST. Has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Altered thermal stratification of lakes	1	SMALL COST. Has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Temperature effects on sediment transport capacity	1	SMALL COST. Has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Scouring caused by discharged cooling water	1	SMALL COST. Has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Eutrophication	1	SMALL COST. Has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Discharge of chlorine or other biocides	1	SMALL COST. Effects are readily controlled through National Pollutant Discharge Elimination System (NPDES) permit and periodic modifications, if needed, and is not expected to be a problem during the license renewal term.
Discharge of sanitary wastes	1	SMALL COST. Effects are readily controlled through NPDES permit and periodic modifications, if needed, and is not expected to be a problem during the license renewal term.
Discharge of other chemical contaminants (e.g., metals)	1	SMALL COST. Has not been found to be a problem at operating nuclear power plants with cooling-tower-based heat dissipation systems. Has been satisfactorily mitigated at other plants. It is not expected to be a problem during the license renewal term.

TABLE B-1. SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS—Continued

Issue	Category[1]	Findings[2]
Water-use conflicts	1	SMALL COST. Has not been found to be a problem at operating nuclear power plants with once-through heat dissipation systems. The issue has been a concern at two nuclear power plants with cooling ponds and at two plants with cooling towers, but it will be resolved with appropriate state or regional regulatory agencies outside of NRC license renewal actions. It is not expected to be a problem during the license renewal term.
Aquatic Ecology (for all plants)		
Refurbishment	1	SMALL COST. During plant shutdown and refurbishment there will be negligible effects on aquatic biota due to a reduction of entrainment and impingement of organisms or reduced release of chemicals.
Accumulation of contaminants in sediments or biota	1	SMALL COST. Has been a concern at a single nuclear power plant with a cooling pond, but has been satisfactorily mitigated. Has not been found to be a problem at operating nuclear power plants with cooling towers or once-through cooling systems, or a cooling pond, except for one plant. It was successfully mitigated at that plant. It is not expected to be a problem during the license renewal term.
Entrainment of phytoplankton and zooplankton	1	SMALL COST. Has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Cold shock	1	SMALL COST. Has been satisfactorily mitigated at operating nuclear plants with once-through cooling systems and has not endangered fish populations. Has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds. It is not expected to be a problem during the license renewal term.
Thermal plume barrier to migrating fish	1	SMALL COST. Has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Premature emergence of aquatic insects	1	SMALL COST. Has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Gas supersaturation (gas bubble disease)	1	SMALL COST. Previously a concern at a small number of operating nuclear power plants with once-through cooling systems, but has been satisfactorily migated. Has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds. It is not expected to be a problem during the license renewal term.
Low dissolved oxygen in the discharge	1	SMALL COST. Has been a concern at one nuclear power plant with a once-through cooling system, but issue will be monitored in the NPDES permit renewal process. Has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds. It is not expected to be a problem during the license renewal term.
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses.	1	SMALL COST. Has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Stimulation of nuisance organisms (e.g., shipworms)	1	SMALL COST. Has been satisfactorily mitigated at the single nuclear power plant with a once-through cooling system where it was a problem. Has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds. It is not expected to be a problem during the license renewal term.
Aquatic Ecology (for plant with once-through heat dissipation systems)		
Entrainment of fish and shellfish in early life stages	2	SMALL COST. Has not been found to be a problem at most operating plants and is not expected to be a problem during the license renewal term. Licensees of plants that do not have an approved Clean Water Act 316(b) determination or equivalent State permit at the time of license renewal application must evaluate the entrainment issue in the license renewal application.
Impingement of fish and shellfish	2	SMALL COST. Has not been found to be a problem at most operating plants and is not expected to be a problem during the license renewal term. Licensees, of plants that do not have an approved Clean Water Act 316(b) determination or equivalent State permit if required at the time of license renewal application must evaluate the impingement issue in the license renewal application.
Heat shock	2	SMALL COST. Has not been found to be a problem at most operating plants and is not expected to be a problem during the license renewal term. Licensees, of plants that do not have an approved Clean Water Act 316(b) determination or equivalent State permit, if required, at the time of license renewal application must evaluate the heat shock issue in the license renewal application.
Aquatic Ecology (for plants with cooling-tower-based heat dissipation systems)		
Entrainment of fish and shellfish in early life stages	1	SMALL COST. Has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.
Impingement of fish and shellfish	1	SMALL COST. Has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.
Heat shock	1	SMALL COST. Has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.

TABLE B-1. SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS—Continued

Issue	Category[1]	Findings[2]
Aquatic Ecology (for plants with cooling pond heat dissipation systems)		
Impingement of fish	2	SMALL COST. Has not been found to be a problem at most operating plants and is not expected to be a problem during the license renewal term. Licensees of plants that do not have an approved Clean Water Act 316(b) determination or equivalent State permit at the time of license renewal application must evaluate the impingement issue in the license renewal application.
Entrainment of fish in early life stages	2	SMALL COST. Has not been found to be a problem at most operating plants and is not expected to be a problem during the license renewal term. Licensees of plants that do not have an approved Clean Water Act 316(b) determination or equivalent State permit at the time of license renewal application must evaluate the entrainment issue in the license renewal application.
Heat shock	2	SMALL COST. Has not been found to be a problem at most operating plants and is not expected to be a problem during the license renewal term. Licensees of plants that do not have an approved Clean Water act 316(a) determination or equivalent State permit, if required at the time of license renewal application must evaluate the heat shock issue in the license renewal application.
Groundwater Use and Quality, Impacts of Refurbishment		
Groundwater-use and quality	1	SMALL COST. Extensive dewatering during the original construction on some sites will not be repeated during refurbishment on any sites. Any plants wastes produced during refurbishment will be handled in the same manner as in current operating practices and is not expected to be a problem during the license renewal term.
Groundwater Use and Quality, Impacts of Operation		
Groundwater-use conflicts (potable and service water)	2	SMALL COST. Has not been found to be a problem at most operating plants and is not expected to be a problem during the license renewal term. Plants pumping 100 or more gpm *and* having private wells located within cones of depression of reactor wells are required to assess for use conflict during the license renewal term.
Groundwater-use conflicts (water pumped for dewatering)	2	SMALL COST. Has not been found to be a problem at most operating plants and is not expected to be a problem during the license renewal term. Plants pumping 100 or more gpm *and* having private wells located within cones of depression of plant wells are required to assess for use conflict during the license renewal term.
Groundwater-use conflicts (surface water used as makeup water—potentially affecting aquifer recharge).	1	SMALL COST. Water use conflicts are small and will be resolved as necessary through surface water regulatory mechanism outside of NRC license renewal process and is not expected to be a problem for any plant during the license renewal term.
Groundwater-use conflicts (Ranney wells)	2	SMALL COST. Ranney wells can result in potential groundwater depression beyond site boundary. Impacts of large groundwater withdrawal for cooling tower makeup at nuclear power plants using Ranney wells must be evaluated at the time of application for license renewal.
Groundwater-quality degradation (Ranney wells)	1	SMALL COST. Groundwater quality at river sites may be degraded by induced infiltration of poor-quality river water into an aquifer that supplies large quantities of reactor cooling water. However, the lower quality infiltrating water would not preclude the current uses of groundwater and is not expected to be a problem during the license renewal term.
Groundwater-quality degradation (saltwater intrusion)	1	SMALL COST. Nuclear power plants do not contribute significantly to saltwater intrusion.
Groundwater-quality degradation (cooling ponds)	2	SMALL COST. Sites with closed-cycle cooling ponds may degrade groundwater quality. This is not an issue for those plants located in salt marshes. However, for those plants located inland, the quality of the groundwater in the vicinity of the ponds must be shown to be adequate to allow continuation of current uses.
Terrestrial Resources		
Refurbishment impacts	2	SMALL COST. Insignificant impact if no loss of important plant and animal habitat occurs. If important plant and animal habitats are affected the potential impact will be assessed at the time of license renewal.
Cooling tower impacts on crops	1	SMALL COST. Salt drift, icing, fogging, or increased humidity associated with cooling tower operation have not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Cooling tower impacts on native plants	1	SMALL COST. Salt drift, icing, fogging, or increased humidity associated with cooling tower operation have not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Birds colliding with cooling towers	1	SMALL COST. Has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Cooling pond impacts on terrestrial resources	1	SMALL COST. No significant damage to vegetation has been observed as a result of fogging, icing, or increased relative humidity at nuclear reactor cooling ponds. The low levels of water contaminants in cooling ponds are not a threat to wildlife using the ponds. No significant impact is expected at any nuclear power plant during the license renewal term.
Power line right of way management (cutting and herbicide application).	1	SMALL COST. Periodic vegetation control causes cyclic changes in the density of wildlife populations dependent on the right-of-way, but long-term densities appear relatively stable. Numerous studies show neither significant positive nor negative effects of power line right-of-way on wildlife. No significant impact is expected at any nuclear power plant during the license renewal term.
Birds colliding with power lines	1	SMALL COST. Has not been found to be a problem at operating nuclear power plant and is not expected to be a problem during the license renewal term.

TABLE B-1. SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS—Continued

Issue	Category[1]	Findings[2]
Impacts of electromagnetic fields (EMFs) on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock).	1	SMALL COST. No significant impacts of electromagnetic fields on terrestrial flora and fauna have been identified as is not expected to be a problem during the license renewal term.
Floodplains and wetland on power line right of way	1	SMALL COST. Periodic vegetation control is necessary in forested wetlands underneath power lines and can be achieved with minimal damage to the wetland. On rare occasions when heavy equipment may need to enter a wetland to repair a power line, impacts can be minimized through the use of standard practices. No significant impact is expected at any nuclear power plant during the license renewal term.
	Threatened or Endangered Species (for all plants)	
Threatened or endangered species	3	Generally, reactor refurbishment and continued operation is not expected to adversely affected threatened or endangered species. However, consultation with appropriate agencies must occur to determine if, in fact, threatened or endangered species are present and if they will be adversely affected.
	Air Quality	
Air quality	1	SMALL COST. Air quality impacts from reactor refurbishment associated with license renewal are expected to be small.
	Land Use	
Cnsite land use	1	SMALL COST. Projected on-site land use changes required during refurbishment and the renewal period would be a small fraction of any nuclear power plant site.
	Human Health, Impacts of Refurbishment	
Radiation exposures to the public	1	SMALL COST. During refurbishment, the gaseous effluents would result in doses well below the natural background dose. Applicable regulatory dose limits to the public are not expected to be exceeded.
Occupational radiation exposures	1	SMALL COST. Average occupational doses from refurbishment are expected to be within the range of annual average doses experienced for pressurized-water reactors and boiling-water reactors. Upper-limit cancer and genetic risks from radiation exposure from the incremental doses from refurbishment are expected to be less than 1% of the natural cancer and genetic risks.
	Human Health, Impacts of Operation During License Renewal	
Microbiological organisms (occupational health)	1	SMALL COST. Occupational health questions are expected to be resolved using industrial hygiene principles to minimize worker exposures.
Microbiological organisms (public health)	2	SMALL COST. Has not been found to be a problem at most operating plants and is not expected to be a problem during the license renewal term. At the time of license renewal of plants using cooling ponds, lakes, or canals and plants discharging to small rivers applicants will assess the impact of thermophilic organisms on the health of recreational users of affected water.
Noise	1	SMALL COST. Has not been found to be a problem at operating plants and is not expected to be a problem at any reactor during the license renewal term.
Electromagnetic fields, acute effects (electric shock)	2	SMALL COST. Has not been found to be problem at most operating plants and is not expected to be a problem during the license renewal term. If it cannot be found at the time of license renewal that the transmission lines of the plant meets the National Electric Safety Code recommendations regarding the prevention of shock from induced currents then an assessment of the potential electric shock hazard from the transmission lines of the plant must be provided.
Electromagnetic fields, chronic effects	1	SMALL COST. Biological and physical studies of 60-Hz electromagnetic fields have not found consistent evidence linking harmful effects with field exposures.
Radiation exposures to public	1	SMALL COST. Present radiation doses to the public are very small with respect to natural background radiation; and doses from refurbishment are expected to be similar in magnitudes.
Occupational radiation exposures	1	SMALL COST. Projected maximum occupational doses during the license renewal term are within the range of doses experienced and are considerably below the 5 rem exposure limit.
	Socioeconomics	
Housing impacts of refurbishment	2	SMALL COST. Not expected to be a problem at any plant located in a medium or high population area and not in an area where growth control measures that limit housing development are in effect. Housing impacts of the workforce associated with refurbishment will be assessed at the time of license renewal for plants located in sparsely populated areas or in areas with growth control measures that limit housing development.
Housing impacts of license renewal term	2	SMALL COST. Not expected to be a problem at any plant located in a medium or high population area and not in an area where growth control measures that limit housing development are in effect. Housing impacts of the workforce associated with refueling/maintenance outages will be assessed at the time of license renewal for plants located in sparsely populated areas or in areas with growth control measures that limit housing development.
Public service impacts of refurbishment	1	SMALL COST. Refurbishment induced population growth will be small and will not strain local infrastructure at any plant.

TABLE B-1. SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS—Continued

Issue	Category[1]	Findings[2]
Transportation impacts of refurbishment	3	Impacts are generally expected to be small, however, they must be assessed for each plant to consider the increase in traffic associated with the additional workers and the local road and traffic control conditions.
Public service (including transportation) impacts during license renewal term.	1	SMALL COST. No significant impacts are expected during the license renewal term.
Offsite land-use impacts of refurbishment	1	SMALL COST. Impacts will not be significant at any plant because plant-induced population growth will have little effect on land use patterns.
Offsite land-use impacts of license renewal term	1	SMALL COST. Changes in land use would be associated with population and tax revenue changes resulting from license renewal of a plant. These changes are expected to be small for all plants.
Historic resources impacts of refurbishment	1	SMALL COST. No significant impacts are expected during refurbishment.
Historic resources impacts of license renewal term (transmission lines).	1	SMALL COST. No significant impacts are expected during the license renewal term.
Historic resources impacts of license renewal term (normal operations).	1	SMALL COST. No significant impacts are expected during the license renewal term.
Aesthetic impacts of refurbishment	1	SMALL COST. No significant impacts are expected during refurbishment.
Aesthetic impacts of license renewal term	1	SMALL COST. Impacts will be small to moderate depending on the visual intrusiveness of the plant on historic and aesthetic resources in the area.
Aesthetic impacts of license renewal term (transmission lines).	1	SMALL COST. No significant impacts are expected during the license renewal term.
Uranium Fuel Cycle		
Radiological and nonradiological impacts	1	SMALL COST. Impacts on the U.S. population from radioactive gaseous and liquid releases including radon-222 and technetium-99 is small compared with the impacts of natural background radiation. Nonradiological impacts on the environment are small.
Environmental Impacts of Postulated Accidents		
Design-basis accidents	1	SMALL COST. Regulations require that consequences from design basis events remain acceptable for every plant.
Severe accidents (atmospheric releases)	1	SMALL COST. Risks from atmospheric releases is small.
Severe accidents (fallout onto open bodies of water)	1	SMALL COST. Risk from both the drinking water pathway and the aquatic food pathway are small and interdiction can further reduce both sufficiently for all plants.
Severe accidents (releases from groundwater)	1	SMALL COST. Interdiction and the low probability of base mat penetration yield a low risk to the public for all plants.
Severe accidents (economic consequences)	1	SMALL COST. Predicted costs due to postulated accidents range from $2,000/reactor-year to $374,000/reactor-year.
Severe accident mitigation design alternatives	1	SMALL COST. Low risk to the environment from severe accidents.
Solid Waste Management		
Nonradiological waste	1	SMALL COST. No changes to generating systems are anticipated for license renewal. Existing regulations will ensure proper handling and disposal at all plants.
Low-level radioactive waste storage	2	SMALL COST. Impacts will be small for plants having access to offsite disposal space. For those plants denied the use of off-site disposal space due to delayed compact plans, the potential for ecological habitat disturbance due to construction of on-site storage facilities must be evaluated.
Low-level radioactive waste disposal	2	SMALL COST. Off-site disposal facilities are planning to handle refurbishment and normal operations waste streams for an additional 20 years. If implementation of plans is delayed, plants in affected compact regions or unaffiliated states must plan for extended interim storage for an indefinite period of time and evaluate the impacts of such storage.
Mixed waste	1	SMALL COST. License renewal will not increase the small, continuing risk to human health and the environment posed by mixed waste at all plants.
Spent fuel	1	SMALL COST. A 50% greater volume of spent fuel from an additional 20 years of operation can be safely accommodated on-site with small environmental effects through dry or pool storage at all plants if a permanent repository or monitored retrievable storage facility is not available.
Transportation	1	SMALL COST. Rail and truck transport corridors can safely accommodate increased shipments of radioactive wastes associated with license renewal. Shipments would result in impacts within the scope of the Table S.4 rule and therefore would result in acceptable impact
Decommissioning		
Radiation doses	1	SMALL COST. Doses to the public are small regardless of which decommissioning method is used. Occupational doses would increase no more than 1 man-rem due to buildup of long-lived radionuclides during the license renewal term.
Waste management	1	SMALL COST. Decommissioning at the end of a 20-year license renewal period would generate no more solid wastes than at the end of the current license term. No increase in the quantities of Class C or greater than Class C wastes would be expected.
Air quality	1	SMALL COST. Air quality impacts of decommissioning are expected to be negligible whether at the end of the current operating term or at the end of the license renewal term.
Water quality	1	SMALL COST. The potential for significant water quality impacts from erosion or spills is no greater if decommissioning occurs after a 20-year license renewal period or after the original 40-year operation period, and measures are readily available to avoid such impacts.

TABLE B–1. SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS—Continued

Issue	Category[1]	Findings[2]
Ecological resources	1	SMALL COST. Decommissioning after either the initial operating period or after a 20 year license renewal period is not expected to have any direct ecological impacts.
Socioeconomic impacts	1	SMALL COST. Decommissioning would have some short-term socioeconomic impacts. The impacts would not be increased by delaying decommissioning until the end of a 20-year relicense period, but they might be decreased by population and economic growth.

[1] The numerical entries in this column are based on the following category definitions: Category 1: A generic conclusion on the impact has been reached for all affected nuclear power plants. Category 2: A generic conclusion on the impact has been reached for affected nuclear power plants that fall within defined bounds. Category 3: A generic conclusions on the impact was not reached for any affected nuclear power plants.

[2] The findings in this column apply to Category 1 issues and Category 2 issues if a plant falls within the bounds of the generic analysis. For Part I of this table, the entry in this column indicates the level of need. For Part II of this table, the entry in this column indicates the relative advantages of alternatives to license renewal. For Part III of this table, the entries in this column are benefits or costs, as indicated by the following headings: *Small* impacts are so minor that they warrant neither detailed investigation or consideration of mitigative actions when such impacts are negative. *Moderate* impacts are likely to be clearly evident and usually warrant consideration of mitigation alternatives when such impacts are negative. *Large* impacts involve either a severe penalty or a major benefit and mitigation alternatives are always considered when such impacts are negative.

[3] The uncertainty associated with the economic cost of license renewal leads to the requirement that an applicant demonstrate for license renewal that no cost advantage exists for replacing the plant's equivalent generating capacity by a new coal-fired power plant. If no such demonstration can be made, and applicant shall justify choosing the license renewal alternative. The justification will include an assessment comparing the cost of license renewal to the cost of reasonable alternative replacement generating capacity. Costs considered must include refurbishment and construction, fuel, and operation, and maintenance.

Dated at Rockville, Maryland, this 10th day of September, 1991.

For the Nuclear Regulatory Commission.

Samuel J. Chilk,

Secretary of the Commission.

[FR Doc. 91–22194 Filed 9–16–91; 8:45 am]

BILLING CODE 7590–01–M

FEDERAL DEPOSIT INSURANCE CORPORATION

12 CFR Part 323

RIN 3064–AB05

Appraisals

AGENCY: Federal Deposit Insurance Corporation (FDIC).

ACTION: Notice of proposed rulemaking.

SUMMARY: The FDIC is proposing to amend part 323 to exempt additional transactions from the requirements of the final appraisal rule published on August 20, 1990 (55 FR 33879). If adopted, the proposed amendment would: (1) Eliminate the requirement for regulated institutions to obtain appraisals by certified or licensed appraisers for real estate-related financial transactions having a value, as defined in the rule, of $100,000 or less; (2) permit regulated institutions to use appraisals prepared for loans insured or guaranteed by an agency of the federal government if the appraisal conforms to the requirements of the federal insurer or guarantor; and (3) add a definition of "real estate" and "real property" to clarify that the appraisal regulation does not apply to mineral rights, timber rights, or growing crops.

The FDIC is proposing these amendments to address concerns raised by state nonmember insured banks concerning the cost of complying with the appraisal requirement for certain loans which have not resulted in substantial losses to such banks. If adopted, this proposal would decrease the number of real estate-related financial transactions requiring an appraisal prepared by a certified or licensed appraiser in accordance with the FDIC's final appraisal rule, thereby reducing costs associated with those transactions.

FDIC is soliciting comments regarding all aspects of the proposed rule and is requesting that comments include specific information regarding real estate related loans held by banks where the transaction value is: $50,000 or below; $50,001 to $100,000; and above $100,000. All comments received by the FDIC will be reviewed and given appropriate consideration.

DATES: Comments must be received by November 18, 1991.

ADDRESSES: Comments should be directed to: Hoyle L. Robinson, Executive Secretary, FDIC, 550 17th Street, NW., Washington, DC 20429. Comments may be hand delivered to room F–400 on business days between 8:30 a.m. and 5 p.m. Comments may also be inspected at the same location and times. (FAX number: (202) 898–3838.)

FOR FURTHER INFORMATION CONTACT: (For information on supervisory issues) James D. Leitner, Examination Specialist, Division of Supervision, (202) 898–6790, or Robert F. Miailovich, Assistant Director, DOS, (202) 898–6918; (for information on legal issues) Walter P. Doyle, Counsel, Legal Division, (202) 898–3682; (for information on liquidation issues) N. Jack Taylor, Senior Liquidation Specialist, Division of Liquidation, (202) 898–7326; FDIC, 550 17th Street, NW., Washington, DC 20429.

SUPPLEMENTARY INFORMATION:

Discussion

Background

Title XI of the Financial Institutions Reform, Recovery, and Enforcement Act of 1989 ("FIRREA") directed the FDIC, and the other financial institutions regulatory agencies,[1] to publish appraisal rules for federally related transactions within the jurisdiction of each agency. In accordance with statutory requirements, FDIC's final rule sets minimum standards for appraisals used in connection with federally related transactions and identified those federally related transactions that require a state certified appraiser and those that require either a state certified or licensed appraiser. The final rule was published August 20, 1990 (55 FR 33879).

When Services of Appraiser Required

Section 1121 of FIRREA, 12 U.S.C. 3350, defines a "federally related transaction" as a real estate-related financial transaction which, *inter alia*, requires the service of an appraiser. In the notice of proposed rulemaking published February 22, 1990 (55 FR 6266), the FDIC stated its intention not to require the services of a certified or licensed appraiser for transactions below a $15,000 threshold and asked for specific comment on "the amount and appropriateness of the *de minimis* "level" below which the services of an appraiser would not be required.

The FDIC received over 200 comments on the threshold provision, the overwhelming majority of which suggested raising the threshold. Suggested values ranged from $20,000 to $250,000, with the greatest number of commenters recommending that the threshold be raised to $100,000. However, because title XI of FIRREA expressed a preference for uniform

[1] These are: the Board of Governors of the Federal Reserve System, the Office of the Comptroller of the Currency, the Office of Thrift Supervision, and the National Credit Union Administration. In addition, the Resolution Trust Corporation has issued appraisal rules under title XI of FIRREA.

NUREG–1437
Vol. 1

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Main Report

Final Report

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Division of Regulatory Applications
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555–0001

2. DESCRIPTION OF NUCLEAR POWER PLANTS AND SITES, PLANT INTERACTION WITH THE ENVIRONMENT, AND ENVIRONMENTAL IMPACT INITIATORS ASSOCIATED WITH LICENSE RENEWAL

2.1 INTRODUCTION

Currently, 118[1] commercial nuclear power plants are located at 74 sites in 33 of the contiguous United States. Of these, 57 sites are located east of the Mississippi River, with most of this nuclear capacity located in the Northeast (New England states, New York, and Pennsylvania); the Midwest (Illinois, Michigan, and Wisconsin); and the Southeast (the Carolinas, Georgia, Florida, and Alabama). No commercial nuclear power plants are located in Alaska or Hawaii. Approximately half of these 74 sites contain two or three nuclear units per site. Three of the 118 plants have been shut down and will be decommissioned. The plant characteristics and environmental settings for these nuclear power plant sites are provided in Appendix A. Table 2.1 provides a summary overview of the plants considered in preparing this Generic Environmental Impact Statement (GEIS).

The total capacity of generating U.S. commercial nuclear power plants is approximately 99 GW(e), with plant generating capacities ranging from 67 MW(e) to 1270 MW(e). In 1992, the U.S. electric utility industry generated about 2.8×10^{12} kWh, 21.6 percent of which was supplied by nuclear power. The range of annual electricity production for these plants is approximately 390×10^6 kWh/year to 6900×10^6 kWh/year using an assumed annual capacity factor of 62 percent. It is anticipated that the electric utility industry will seek to operate many of these nuclear power plants beyond the current operating license term of 40 years. This GEIS examines how these plants and their interactions with the environment would change if such plants were allowed to operate (under the proposed license renewal regulation 10 CFR Part 54) for a maximum of 20 years past the term of the original plant license of 40 years.

The purpose of this section is to provide an orientation from the perspective of environmental considerations and assessments. Section 2.2 describes commercial nuclear power plants and their major features and plant systems. Section 2.3 describes the ways nuclear power plants interact with and affect the environment. The license renewal rule, particularly its requirements that may result in changes to nuclear plant environmental impacts, is discussed in Section 2.4. Section 2.5 reviews the generation of particular environment impacts, or precursors to such impacts, that are typical of current nuclear plant operation. It discusses the "baseline" values to be used in comparing incremental effects resulting from license renewal. Section 2.6 describes major refurbishment activities and changes that could occur at nuclear power plants during license renewal refurbishment and the extended years of operation. This section provides the background for more thorough evaluations and environmental impact assessments discussed in Sections 3 through 10.

2.2 PLANT AND SITE DESCRIPTION AND PLANT OPERATION

2.2.1 External Appearance and Setting

Nuclear power plants generally contain four main buildings or structures:

- Containment or reactor building. A massive containment structure that houses the reactor vessel, the suppression pool [boiling-water reactors (BWRs) only], steam generators, pressurizer [pressurized-water reactors (PWRs) only], pumps, and associated piping. The building is generally designed to withstand such disasters as hurricanes, earthquakes, and aircraft collisions. The containment's ability to withstand such disasters, as well as the effects of accidents initiated by system failures, is the principal deterrent to release of radioactive materials to the environment.
- Turbine building. Plant structures that house the steam turbine and generator, condenser, waste heat rejection system, pumps, and equipment that supports those systems.
- Auxiliary buildings. Buildings that house such support systems as the ventilation system, the emergency core cooling system, the water treatment system, and the waste treatment system, along with fuel storage facilities and the plant control room.
- Cooling towers. Structures designed to remove excess heat from the condenser without dumping such heat directly into water bodies.

A plant site also contains a large switchyard, where the electric voltage is stepped up and fed into the regional power distribution system, and may also include various administrative and security buildings. During the operating life of a plant, its basic appearance remains unchanged.

Typically, nuclear power plant sites and the surrounding area are flat-to-rolling countryside in wooded or agricultural areas. More than 50 percent of the sites have 80-km (50-mile) population densities of less than 200 persons per square mile, and over 80 percent have 80-km (50-mile) densities of less than 500 persons per square mile. The most notable exception is the Indian Point Station, located within 80 km (50 miles) of New York City, which has a projected 1990 population density within 80 km (50 miles) of almost 2000 persons per square mile.

Site areas range from 34 ha (84 acres) for the San Onofre Nuclear Generating Station in California to 12,000 ha (30,000 acres) for the McGuire Nuclear Station in North Carolina. As shown in Table 2.1, 28 site areas range from 200 to 400 ha (500 to 1000 acres), and an additional 12 sites are in the 400- to 800-ha (1000- to 2000-acre) range. Thus, almost 60 percent of the plant sites encompass 200 to 800 ha (500 to 2000 acres). Larger land-use areas are associated with plant cooling systems that include reservoirs, artificial lakes, and buffer areas.

2.2.2 Reactor Systems

U.S. reactors employed for domestic electric power generation are conventional (thermal) light-water reactors (LWRs), using water as moderator and coolant. The two types of LWRs are PWRs (Figure 2.1) and BWRs (Figure 2.2). Of the 118 power reactors in the United States, 80 are PWRs and 38 are BWRs.

Table 2.1 Nuclear power plant baseline information

Plant	Unit	Operating license	License expiration	Electrical rating [MW(e)]	Reactor type[a]	Steam supply system vendor[b]	Cooling system[c]	Cooling water source	Condenser flow rate (10^3 gal/min)	Intake structure	Discharge structure	Total site area (acres)	Nearest city	Transmission corridor (acres)	1990 population (50 miles)
Arkansas Nuclear One	1 2	1974 1978	2014 2018	850 912	PWR PWR	B&W CE	OT NDCT	Dardanelle Reservoir	765 422	3220-ft canal	520-ft canal	1,160	Little Rock, Ark.	3,700	200,000
Beaver Valley	1 2	1976 1987	2016 2027	835 836	PWR PWR	WEST WEST	NDCT NDCT	Ohio River	480 480	At river edge	At river edge	501	Pittsburgh	Uses existing corridor	3,740,000
Bellefonte Nuclear Plant	1 2	— —	— —	1,213 1,213	PWR PWR	B&W B&W	NDCT NDCT	Guntersville Lake	410 410	Intake channel	Submerged diffuser	1,500	Huntsville, Ala.	2,900	1,070,000
Big Rock Point Nuclear Plant	1	1962	2002	72	BWR	GE	OT	Lake Michigan	49	Underwater crib	Open discharge canal	600	Sault Ste. Marie, Canada	—	200,000
Braidwood Station	1 2	1987 1988	2027 2028	1,120 1,120	PWR PWR	WEST WEST	CCCP CCCP	Kankakee River	730 730	At lake shore	Surface flume	4,457	Joliet, Ill.	2,376	4,510,000
Browns Ferry Nuclear Power Station	1 2 3	1973 1974 1976	2013 2014 2016	1,065 1,065 1,065	BWR BWR BWR	GE GE GE	OT with towers	Tennessee River	630 630 630	In small river inlet	Diffuser pipes	840	Huntsville, Ala.	1,350	760,000
Brunswick Steam Electric Plant	1 2	1976 1974	2016 2014	821 821	BWR BWR	GE GE	OT OT	Cape Fear River	675 675	3-mile canal from river	6-mile canal to Atlantic Ocean	1,200	Wilmington, N.C.	3,500	230,000
Byron Station	1 2	1985 1987	2025 2027	1,120 1,120	PWR PWR	WEST WEST	NDCT NDCT	Rock River	632 632	On river bank	Discharge to river	1,398	Rockford, Ill.	2,000	1,000,000
Callaway Plant	1	1984	2024	1,171	PWR	WEST	NDCT	Missouri River	530	From river	To river	3,188	Columbia, Mo.	1,140	400,000
Calvert Cliffs Nuclear Power Plant	1 2	1974 1976	2014 2016	845 845	PWR PWR	CE CE	OT OT	Chesapeake Bay	1,200 1,200	560 ft from shore	850 ft from shore	1,135	Washington, D.C.	1,990	3,030,000
Catawba Nuclear Station	1 2	1985 1986	2025 2026	1,145 1,145	PWR PWR	WEST WEST	MDCT MDCT	Lake Wylie	660 660	Skimmer wall	Cove of lake	391	Charlotte, N.C.	584	1,590,000
Clinton Power Station	1	1987	2027	933	BWR	GE	OT	Salt Creek	569	Shoreline of creek	3-mile flume	14,090	Decatur, Ill.	906	730,000
Comanche Peak Steam Electric Station	1 2	1989 —	2029 —	1,150 1,150	PWR PWR	WEST WEST	OT OT	Squaw Creek Reservoir	1,030 1,030	Shore of reservoir	Canal to reservoir	7,669	Ft. Worth, Tex.	458	1,130,000

See footnotes at end of table

Table 2.1 (continued)

Plant	Unit	Operating license	License expiration	Electrical rating [MW(e)]	Reactor type[a]	Steam supply system vendor[b]	Cooling system[c]	Cooling water source	Condenser flow rate (10^3 gal/min)	Intake structure	Discharge structure	Total site area (acres)	Nearest city	Transmission corridor (acres)	1990 population (50 miles)
Donald C. Cook Nuclear Power Plant	1 2	1974 1977	2014 2017	1,030 1,100	PWR PWR	WEST WEST	OT OT	Lake Michigan	800 800	2,250 ft from shore	1,250 ft from shore	650	South Bend, Ind.	3,300	1,250,000
Cooper Nuclear Station	—	1974	2014	778	BWR	GE	OT	Missouri River	631	At shoreline	At shoreline	1,090	Lincoln, Neb.	6,862	180,000
Crystal River Nuclear Plant	3	1977	2017	825	PWR	B&W	OT	Gulf of Mexico	680	16,000 ft from shore	13,000 ft canal	4,738	Gainesville, Fla.	2,140	440,000
Davis-Besse Nuclear Power Station	1	1977	2017	906	PWR	B&W	NDCT	Lake Erie	480	Submerged 3,000 ft off shore	Submerged 900 ft off shore	954	Toledo, Ohio	1,800	1,920,000
Diablo Canyon Nuclear Power Plant	1 2	1984 1985	2024 2025	1,086 1,119	PWR PWR	WEST WEST	OT OT	Pacific Ocean	863 863	At shore with break wall	Surface to ocean	750	Santa Barbara, Calif.	6,000	300,000
Dresden Nuclear Power Station	2 3	1969 1971	2010 2011	794 794	BWR BWR	GE GE	Cooling lake and spray canal	Kankakee River	471 471	Canal from Kankakee River	Cooling lake to Illinois River	953 + 1,274 cooling pond	Joliet, Ill.	2,250	6,820,000
Duane Arnold Energy Center	1	1974	2014	538	BWR	GE	MDCT	Cedar River	290	Shoreline	Canal to shoreline	500	Cedar Rapids, Iowa	1,160	620,000
Joseph M. Farley Nuclear Plant	1 2	1977 1981	2017 2021	829 829	PWR PWR	WEST WEST	MDCT MDCT	Chattahoochee River	635 635	River to storage pond	At river bank	1,850	Columbus, Ga.	5,300	390,000
Enrico Fermi Atomic Power Plant	2	1985	2025	1,093	BWR	GE	NDCT	Lake Erie	837	At edge of lake	Pond to lake	1,120	Detroit	180	5,370,000
James A. FitzPatrick Nuclear Power Plant	—	1974	2014	816	BWR	GE	OT	Lake Ontario	353	From lake	To lake	702	Syracuse, N.Y.	1,000	820,000
Fort Calhoun Station	1	1973	2013	478	PWR	CE	OT	Missouri River	360	At shore	At shore	660	Omaha, Neb.	186	770,000
Robert Emmett Ginna Nuclear Power Plant	1	1969	2009	470	PWR	WEST	OT	Lake Ontario	356	Lake bottom	Open canal	338	Rochester, N.Y.	280	1,140,000
Grand Gulf Nuclear Station	1	1984	2024	1,250	BWR	GE	NDCT	Mississippi River	572	Collector wells	Discharge via barge slip	2,100	Jackson, Miss.	2,300	350,000

See footnotes at end of table.

Table 2.1 (continued)

Plant	Unit	Operating license	License expiration	Electrical rating [MW(e)]	Reactor type[a]	Steam supply system vendor[b]	Cooling system[c]	Cooling water source	Condenser flow rate (10^3 gal/min)	Intake structure	Discharge structure	Total site area (acres)	Nearest city	Transmission corridor (acres)	1990 population (50 miles)
Haddam Neck (Connecticut Yankee)	—	1967	2007	582	PWR	WEST	OT	Connecticut River	372	Shoreline	Canal to river	525	Meridian, Conn.	985	3,630,000
Shearon Harris Nuclear Power Plant	1	1987	2027	900	PWR	WEST	NDCT	Buckhorn Creek	483	Reservoir on creek	To reservoir	10,744	Raleigh, N.C.	3,500	1,430,000
Edwin I. Hatch Nuclear Plant	1 2	1974 1978	2014 2018	776 784	BWR BWR	GE GE	MDCT	Altamaha River	556	Edge of river	120 ft from shore	2,244	Savannah, Ga.	4,691	330,000
Hope Creek Generating Station	1	1986	2026	1,067	BWR	GE	NDCT	Delaware River	552	Edge of river	10 ft from shore	740	Wilmington, Del.	912	4,850,000
Indian Point Station	2 3	1973 1976	2013 2016	873 965	PWR PWR	WEST WEST	OT	Hudson River	840	At river bank	Channel to river	239	White Plains, N.Y.	10	15,190,000
Kewaunee Nuclear Power Plant	—	1973	2013	535	PWR	WEST	OT	Lake Michigan	420	1,750 ft from shore	At shoreline	908	Green Bay, Wisc.	1,066	640,000
La Salle County Station	1 2	1982 1984	2022 2024	1,078 1,078	BWR BWR	GE GE	Cooling pond	Illinois River	645	From cooling pond	To cooling pond	3,060	Joliet, Ill.	2,278	1,160,000
Limerick Generating Station	1 2	1985 1990	2025 2030	1,055 1,055	BWR BWR	GE GE	NDCT NDCT	Schuylkill River	450	From river	To river	595	Reading, Pa.	7	6,970,000
Maine Yankee Atomic Plant	—	1973	2013	825	PWR	CE	OT	Back River	426	River bank	Bay on Back River	740	Portland, Maine	220	640,000
William B. McGuire Nuclear Station	1 2	1981 1983	2021 2023	1,180 1,180	PWR PWR	WEST WEST	OT	Lake Norman	675	Submerged and surface at shoreline	2,000-ft canal discharge	30,000	Charlotte, N.C.	62	1,750,000
Millstone Nuclear Power Plant	1 2 3	1970 1975 1986	2010 2015 2026	660 870 1,154	BWR PWR PWR	GE CE WEST	OT OT OT	Long Island Sound	420 523 907	Niantic Bay	Via holding ponds	500	New Haven, Conn.	927	2,760,000
Monticello Nuclear Generating Plant	—	1970	2010	545	BWR	GE	OT with towers	Mississippi River	280	Canal	Canal	1,325	Minneapolis, Minn.	1,454	2,170,000
North Anna Power Station	1 2	1978 1980	2018 2020	907 907	PWR PWR	WEST WEST	OT	Lake Anna	940	Lake shore	Via cooling pond	18,643	Richmond, Va.	3,528	1,150,000

See footnotes at end of table.

Table 2.1 (continued)

Plant	Unit	Operating license	License expiration	Electrical rating [MW(e)]	Reactor type[a]	Steam supply system vendor[b]	Cooling system[c]	Cooling water source	Condenser flow rate (10^3 gal/min)	Intake structure	Discharge structure	Total site area (acres)	Nearest city	Transmission corridor (acres)	1990 population (50 miles)
Nine Mile Point Nuclear Station	1 2	1968 1987	2008 2027	620 1,080	BWR BWR	GE GE	OT NDCT	Lake Ontario	250 580	Pipelines 1,000 ft off shore	Diffuser pipe	900	Syracuse, N.Y.	1,640	820,000
Oconee Nuclear Station	1 2 3	1973 1973 1974	2013 2013 2014	887 887 887	PWR PWR PWR	B&W B&W B&W	OT	Lake Keowee	680	710-ft deep skimmer wall	765 ft deep	510	Greenville, S.C.	7,800	990,000
Oyster Creek Generating Station	1	1969	2009	650	BWR	GE	OT	Barnegat Bay	460	Forked River from bay	Forked River to bay	1,416	Atlantic City, N.J.	322	4,030,000
Palisades Nuclear Plant	1	1972	2012	805	PWR	CE	MDCT	Lake Michigan	405	Crib 3,300 ft from shore	108-ft canal	487	Kalamazoo, Mich.	2,250	1,170,000
Palo Verde Generating Station	1 2 3	1985 1986 1987	2025 2026 2027	1,270 1,270 1,270	PWR PWR PWR	CE CE CE	MDCT	Phoenix City Sewage Treatment Plant	560	35-mile pipe	Evaporation ponds	4,050	Phoenix, Ariz.	16,600	1,180,000
Peach Bottom Atomic Power Station	2 3	1973 1974	2013 2014	1,065 1,065	BWR BWR	GE GE	OT with towers	Conowingo Pond	750	Small intake pond	5,000-ft canal	620	Lancaster, Pa.	1,030	4,660,000
Perry Nuclear Power Station	1	1986	2026	1,205	BWR	GE	NDCT	Lake Erie	545	Multiport 2,250 ft off shore	Diffuser 1,650 ft off shore	1,100	Euclid, Ohio	1,500	2,480,000
Pilgrim Nuclear Power Station	1	1972	2012	655	BWR	GE	OT	Cape Cod Bay	311	Edge of bay	850-ft canal	517	Brockton, Mass.	174	4,440,000
Point Beach Nuclear Plant	1 2	1970 1972	2010 2012	497 497	PWR PWR	WEST WEST	OT	Lake Michigan	350	1,750 ft from shore	Flumes 150 ft from shore	2,065	Green Bay, Wisc.	3,321	610,000
Prairie Island Nuclear Generating Plant	1 2	1973 1974	2013 2014	530 530	PWR PWR	WEST WEST	MDCT or OT	Mississippi River	294	Short canal	Basin to towers and/or river	560	Minneapolis, Minn.	973	2,290,000
Quad-Cities Station	1 2	1972 1972	2012 2012	789 789	BWR BWR	GE GE	OT	Mississippi River	471	Edge of river	14,000-ft spray canal	784	Davenport, Iowa	1,400	740,000
Rancho Seco Nuclear Station	1	1974	2014	918	PWR	B&W	NDCT	Folsom Canal	446	3.5-mile pipe	1.5-mile pipe to reservoir	2,480	Sacramento, Calif.	870	2,010,000

See footnotes at end of table.

Table 2.1 (continued)

Plant	Unit	Operating license	License expiration	Electrical rating [MW(e)]	Reactor type[a]	Steam supply system vendor[b]	Cooling system[c]	Cooling water source	Condenser flow rate (10^3 gal/min)	Intake structure	Discharge structure	Total site area (acres)	Nearest city	Transmission corridor (acres)	1990 population (50 miles)
River Bend Station	1	1985	2025	936	BWR	GE	MDCT	Mississippi River	508	At river bank	Into river	3,342	Baton Rouge, La.	1,014	800,000
H. B. Robinson Plant	2	1970	2010	700	PWR	WEST	OT	Lake Robinson	482	Edge of lake	4.2-mile canal	5,000	Columbia, S.C.	1,024	740,000
Salem Nuclear Generating Station	1 2	1976 1981	2016 2021	1,115 1,115	PWR PWR	WEST WEST	OT	Delaware River	1,100	Edge of river	500 ft into river	700	Wilmington, Del.	3,900	4,810,000
San Onofre Nuclear Generating Station	1 2 3	1967 1982 1983	2007 2022 2023	436 1,070 1,080	PWR PWR PWR	WEST CE CE	OT	Pacific Ocean	341 797 797	3,200 to 3,400 ft off shore	2,600 to 8,500 ft from shore	84	Oceanside, Calif.	1,100	5,430,000
Seabrook Station	1	1990	2032	1,198	PWR	WEST	OT	Atlantic Ocean	399	7,000 ft off shore	5,500 ft off shore	896	Lawrence, Mass.	1,545	3,760,000
Sequoyah Nuclear Plant	1 2	1980 1981	2020 2021	1,148 1,148	PWR PWR	WEST WEST	OT and/or NDCT	Chicka-mauga Lake	522	From lake	To lake	525	Chattanooga, Tenn.	1,260	930,000
Shoreham Nuclear Power Station	—	—	—	819	BWR	GE	OT	Long Island Sound	574	Intake canal	Diffuser system	499	New Haven, Conn.	39	5,390,000
South Texas Project	1 2	1988 1989	2028 2029	1,250 1,250	PWR PWR	WEST WEST	CCCP	Colorado River	907	Bank of river	Bank of river	12,350	Galveston, Texas	4,773	270,000
St. Lucie Plant	1 2	1976 1983	2016 2023	830 830	PWR PWR	CE CE	OT	Atlantic Ocean	491	1,200 ft off shore	>1,200 ft off shore	1,132	West Palm Beach, Fla.	760	690,000
Virgil C. Summer Nuclear Station	1	1982	2022	900	PWR	WEST	OT	Lake Monticello	485	Intake at shoreline	Discharge pond to lake	2,200	Columbia, S.C.	1,576	910,000
Surry Power Station	1 2	1972 1973	2012 2013	788 788	PWR PWR	WEST WEST	OT	James River	840	1.7-mile canal	2900-ft canal	840	Newport News, Va.	4,420	1,900,000
Susquehanna Steam Electric Station	1 2	1982 1984	2022 2024	1,050 1,050	BWR BWR	GE GE	NDCT	Susquehanna River	448	River bank	240 ft from bank	1,075	Wilkes-Barre, Pa.	1,800	1,500,000
Three Mile Island Nuclear Station	1	1974	2014	819	PWR	B&W	NDCT	Susquehanna River	430	At river bank	At shoreline	472	Harrisburg, Pa.	1,790	2,170,000

See footnotes at end of table.

Table 2.1 (continued)

Plant	Unit	Operating license	License expiration	Electrical rating [MW(e)]	Reactor type[a]	Steam supply system vendor[b]	Cooling system[c]	Cooling water source	Condenser flow rate (10^3 gal/min)	Intake structure	Discharge structure	Total site area (acres)	Nearest city	Transmission corridor (acres)	1990 population (50 miles)
Trojan Nuclear Plant	1	1975	2015	1,130	PWR	WEST	NDCT	Columbia River	429	At river bank	350 ft from bank	635	Portland, Ore.	1,260	1,850,000
Turkey Point Plant	3 4	1972 1973	2012 2013	693 693	PWR PWR	WEST WEST	Closed-cycle canal	Biscane Bay	624	Intake canal and barge canal	Canal system	24,000	Miami	817	2,70[illegible],000
Vermont Yankee Nuclear Power Station	1	1973	2013	540	BWR	GE	OT and towers	Connecticut River	366	Edge of river	Edge of river	125	Holyoke, Mass.	1,550	1,510,000
Vogtle Electric Generating Plant	1 2	1987 1989	2027 2029	1,101 1,160	PWR PWR	WEST WEST	NDCT	Savannah River	510	At river bank	Near shoreline	3,169	Augusta, Ga.	—	630,000
Waterford Steam Electric Station	3	1985	2025	1,104	PWR	CE	OT	Mississippi River	975	At river bank	At river bank	3,561	New Orleans	280	1,970,000
Watts Bar Nuclear Plant	1 2	— —	— —	1,170 1,170	PWR PWR	WEST WEST	NDCT NDCT	Chickamauga Lake	410	At lake bank	Holding pond to lake	1,170	Chattanooga, Tenn.	3,165	950,000
Washington Nuclear Project (WNP)	2	1984	2024	1,100	BWR	GE	MDCT	Columbia River	550	Offshore	175 ft from shoreline	Department of Energy, Hanford Reservation	Richland, Wash.	Hanford Reservation	280,000
Wolf Creek Generation Station	1	1985	2025	1,170	PWR	WEST	CCCP	Wolf Creek	500	Cooling lake	Cooling lake to embayment	9,818	Topeka, Kansas	2,900	200,000
Yankee Nuclear Power Station	1	1960	2000	175	PWR	WEST	OT	Deerfield River	140	Sherman Pond, 90 ft below surface	Sherman Pond	2,000	Pittsfield, Mass.	—	1,720,000
Zion Nuclear Plant	1 2	1973 1973	2013 2013	1,040 1,040	PWR PWR	WEST WEST	OT OT	Lake Michigan	735	2600 ft off shore	760 ft off shore	250	Waukegan, Ill.	145	7,480,000

[a]PWR = pressurized-water reactor; BWR = boiling-water reactor.
[b]B-W = Babcock and Wilcox; GE = General Electric; WEST = Westinghouse; C-E = Combustion-Engineering.
[c]OT = once through; NDCT = natural draft cooling tower; MDCT = mechanical draft cooling tower; CCCP = closed cycle cooling pond, lake, or reservoir.

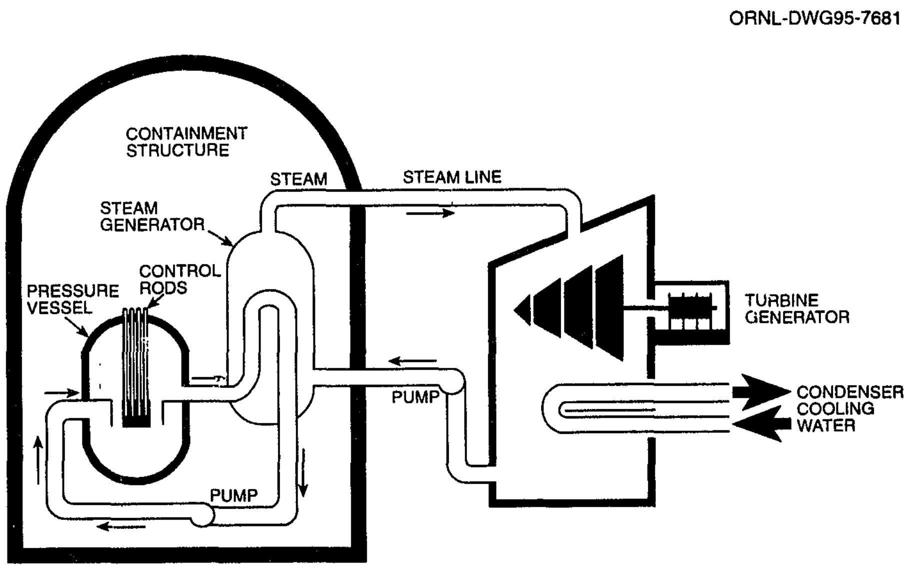

Figure 2.1 Pressurized-water-reactor power generation system.

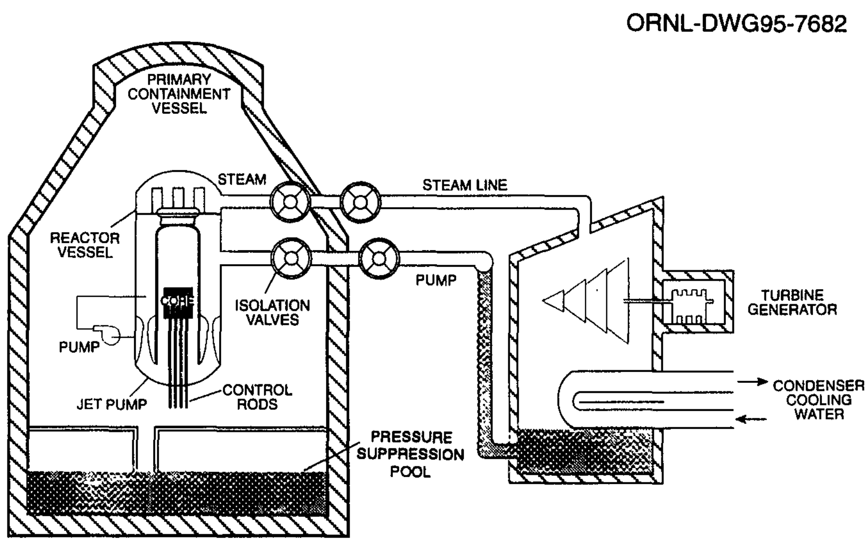

Figure 2.2 Boiling-water-reactor generating system.

In the PWR, reactor heat is transferred from the primary coolant to a secondary coolant loop that is at a lower pressure, allowing steam to be generated in the steam generator. The steam then flows to a turbine for power production. In contrast, the BWR generates steam directly within the reactor core, which passes through moisture separators and steam dryers and then flows to the turbine.

All domestic power reactors employ a containment structure as a major safety feature to prevent the release of radionuclides in the event of an accident. PWRs employ three types of containments: (1) large, dry containments; (2) subatmospheric containments; and (3) ice condenser containments. Of the 80 U.S. PWRs, 65 have large, dry containments; 7 have subatmospheric containments; and 8 have ice condenser containments. BWR containments typically are composed of a suppression pool and dry well. Three types of BWR containments (Mark I, Mark II, and Mark III) have evolved. There are 24 Mark I, 10 Mark II, and 4 Mark III containment designs in the United States.

NUREG/CR-5640 provides a comprehensive overview and description of U.S. commercial nuclear power plant systems.

2.2.3 Cooling and Auxiliary Water Systems

The predominant water use at a nuclear power plant is for removing excess heat generated in the reactor by condenser cooling. The quantity of water used for condenser cooling is a function of several factors, including the capacity rating of the plant and the increase in cooling water temperature from the intake to the discharge. The larger the plant, the greater the quantity of waste heat to be dissipated, and the greater the quantity of cooling water required.

In addition to removing heat from the reactor, cooling water is also provided to the service water system and to the auxiliary cooling water system. The volume of water required for these systems for once-through cooling is usually less than 15 percent of the volume required for condenser cooling. In closed-cycle cooling, the additional water needed is usually less than 5 percent of that needed for condenser cooling.

Of the 118 nuclear reactors, 48 use closed-cycle cooling systems (see Table 2.2, which groups the 74 plant sites into three broad categories according to environment). Most closed-cycle systems use cooling towers. Some closed-cycle system units use a cooling lake or canals for transferring heat to the atmosphere. Once-through cooling systems are used at 70 units. A few of these systems are augmented with helper cooling towers to reduce the temperature of the effluent released to the adjacent body of water.

In closed-cycle systems, the cooling water is recirculated through the condenser after the waste heat is removed by dissipation to the atmosphere, usually by circulating the water through large cooling towers constructed for that purpose. Several types of closed-cycle cooling systems are currently used by the nuclear power industry. Recirculating cooling systems consist of either natural draft or mechanical draft cooling towers, cooling ponds, cooling lakes, or cooling canals. Because the predominant cooling mechanism associated with closed-cycle systems is evaporation, most of the water

Table 2.2 Types of cooling systems used at nuclear power sites

Plant site	State	Cooling system[a]
Coastal or estuarine environment		
Diablo Canyon Nuclear Power Plant	California	Once through
San Onofre Nuclear Generating Station	California	Once through
Millstone Nuclear Power Plant	Connecticut	Once through
Crystal River Nuclear Plant	Florida	Once through
St. Lucie Plant	Florida	Once through
Turkey Point Plant	Florida	Cooling canal
Maine Yankee Atomic River Plant	Maine	Once through
Calvert Cliffs Nuclear Power Plant	Maryland	Once through
Pilgrim Nuclear Power Plant	Massachusetts	Once through
Seabrook Station	New Hampshire	Once through
Hope Creek Generating Station	New Jersey	Towers (natural draft)
Oyster Creek Generating Station	New Jersey	Once through
Salem Nuclear Generating Station	New Jersey	Once through
Indian Point Station	New York	Once through
Shoreham Nuclear Power Station	New York	Once through
Brunswick Steam Electric Plant	North Carolina	Once through
South Texas Project	Texas	Cooling pond
Surry Power Station	Virginia	Once through
Great Lakes shoreline environment		
Zion Nuclear Plant	Illinois	Once through
Big Rock Point Nuclear Plant	Michigan	Once through
Donald C. Cook Nuclear Power Plant	Michigan	Once through
Enrico Fermi Atomic Power Plant	Michigan	Towers (natural draft) and pond
Palisades Nuclear Plant	Michigan	Towers (mechanical draft)
James A. FitzPatrick Nuclear Power Plant	New York	Once through
Robert Emmett Ginna Nuclear Power Plant	New York	Once through
Nine Mile Point Nuclear Station	New York	Once through and towers
Davis-Besse Nuclear Power Station	Ohio	Towers (natural draft)
Perry Nuclear Power Station	Ohio	Towers (natural draft)
Kewaunee Nuclear Power Plant	Wisconsin	Once through
Point Beach Nuclear Plant	Wisconsin	Once through
Freshwater riverine or impoundment environment		
Bellefonte Nuclear Plant	Alabama	Towers (natural draft)
Browns Ferry Nuclear Power Plant	Alabama	Once through and helper towers
Joseph M. Farley Nuclear Plant	Alabama	Towers (mechanical draft)
Palo Verde Generating Station	Arizona	Towers (mechanical draft)
Arkansas Nuclear One	Arkansas	Once through and towers
Rancho Seco Nuclear Station	California	Towers (natural draft)
Haddam Neck Plant (Connecticut Yankee)	Connecticut	Once through
Edwin I. Hatch Nuclear Plant	Georgia	Towers (mechanical draft)
Vogtle Electric Generating Plant	Georgia	Towers (natural draft)
Braidwood Station	Illinois	Cooling pond
Byron Station	Illinois	Towers (natural draft)
Clinton Power Station	Illinois	Cooling pond

Table 2.2 (continued)

Plant site	State	Cooling system[a]
Freshwater riverine or impoundment environment (continued)		
Dresden Nuclear Power Station	Illinois	Spray canal and cooling pond
La Salle Country Station	Illinois	Cooling pond
Quad Cities Station	Illinois	Once through
Duane Arnold Energy Center	Iowa	Towers (mechanical draft)
Wolf Creek Generation Station	Kansas	Cooling pond
River Bend Station	Louisiana	Towers (mechanical draft)
Waterford Steam Electric Station	Louisiana	Once through
Yankee Nuclear Power Station	Massachusetts	Once through
Monticello Nuclear Generating Plant	Minnesota	Variable (mechanical draft)
Prairie Island Nuclear Generating Plant	Minnesota	Variable (mechanical draft)
Grand Gulf Nuclear Station	Mississippi	Towers (natural draft)
Callaway Plant	Missouri	Towers (natural draft)
Cooper Nuclear Station	Nebraska	Once through
Fort Calhoun Station	Nebraska	Once through
Shearon Harris Nuclear Power Plant	North Carolina	Towers (natural draft)
William B. McGuire Nuclear Station	North Carolina	Once through
Trojan Nuclear Plant	Oregon	Towers (natural draft)
Beaver Valley	Pennsylvania	Variable (natural draft)
Limerick Generating Station	Pennsylvania	Towers (natural draft)
Peach Bottom Atomic Power Station	Pennsylvania	Once through and towers (mechanical draft)
Susquehanna Steam Plant Station	Pennsylvania	Towers (natural draft)
Three Mile Island Nuclear Station	Pennsylvania	Towers (natural draft)
Catawba Nuclear Station	South Carolina	Towers (mechanical draft)
Oconee Nuclear Station	South Carolina	Once through
H. B. Robinson Plant	South Carolina	Cooling pond
Virgil C. Summer Nuclear Station	South Carolina	Cooling pond
Sequoyah Nuclear Plant	Tennessee	Variable (natural draft)
Watts Bar Nuclear Plant	Tennessee	Towers (natural draft)
Comanche Peak	Texas	Once through
Vermont Yankee Nuclear Power Station	Vermont	Once through and helper towers
North Anna Power Station	Virginia	Once through
Washington Nuclear Project-2	Washington	Towers (mechanical draft)

[a]Of the 48 plants with closed-cycle cooling systems, 15 use mechanical draft cooling towers, 25 use natural draft cooling towers, 4 use a canal system, and 4 use a cooling lake. Of the 70 plants with once-through cooling systems, 24 discharge to a river, 11 discharge to the Great Lakes, 19 discharge to the ocean or an estuary, and 16 discharge to a reservoir or lake. Five of the once-through plants can also switch to cooling towers.

used for cooling is consumed and is not returned to a water source.

In a once-through cooling system, circulating water for condenser cooling is drawn from an adjacent body of water, such as a lake or river, passed through the condenser tubes, and returned at a higher temperature to the adjacent body of water. The waste heat is dissipated to the atmosphere mainly by evaporation from the water body and, to a much smaller extent, by conduction, convection, and thermal radiation loss.

All sites with two or three reactors use the same cooling system for all reactors, except for two sites: Arkansas Nuclear One in Arkansas and Nine Mile Point in New York. These two sites use once-through cooling for one unit and closed-cycle for the other.

For both once-through and closed-cycle cooling systems, the water intake and discharge structures are of various configurations to accommodate the source water body and to minimize impact to the aquatic ecosystem. The intake structures are generally located along the shoreline of the body of water and are equipped with fish protection devices (ORNL/TM-6472). The discharge structures are generally of the jet or diffuser outfall type and are designed to promote rapid mixing of the effluent stream with the receiving body of water. Biocides and other chemicals used for corrosion control and for other water treatment purposes are mixed with the condenser cooling water and discharged from the system.

In addition to surface water sources, some nuclear power plants use groundwater as a source for service water, makeup water, or potable water. Other plants operate dewatering systems to intentionally lower the groundwater table, either by pumping or by using a system of drains, in the vicinity of building foundations.

2.2.4 Radioactive Waste Treatment Systems

During the fission process, a large inventory of radioactive fission products builds up within the fuel. Virtually all of the fission products are contained within the fuel pellets. The fuel pellets are enclosed in hollow metal rods (cladding), which are hermetically sealed to further prevent the release of fission products. However, a small fraction of the fission products escapes the fuel rods and contaminates the reactor coolant. The primary system coolant also has radioactive contaminants as a result of neutron activation. The radioactivity in the reactor coolant is the source of gaseous, liquid, and solid radioactive wastes at LWRs.

The following sections describe the basic design and operation of PWR and BWR radioactive-waste-treatment systems.

2.2.4.1 Gaseous Radioactive Waste

For BWRs, the sources of routine radioactive gaseous emissions to the atmosphere are the air ejector, which removes noncondensable gases from the coolant to improve power conversion efficiency, and gaseous and vapor leakages, which, after monitoring and filtering, are discharged to the atmosphere via the building ventilation systems.

The off-gas treatment system collects noncondensable gases and vapors that are exhausted at the condenser via the air ejectors. These off-gases are processed through a series of delay systems and filters to remove airborne radioactive particulates and halogens, thereby minimizing the quantities of the radionuclides that might be released. Building ventilation system exhausts are another source of gaseous radioactive wastes for BWRs.

PWRs have three primary sources of gaseous radioactive emissions:

- discharges from the gaseous waste management system;
- discharges associated with the exhaust of noncondensable gases at the main

condenser if a primary-to-secondary system leak exists; and

- radioactive gaseous discharges from the building ventilation exhaust, including the reactor building, reactor auxiliary building, and fuel-handling building.

The gaseous waste management system collects fission products, mainly noble gases, that accumulate in the primary coolant. A small portion of the primary coolant flow is continually diverted to the primary coolant purification, volume, and chemical control system to remove contaminants and adjust the coolant chemistry and volume. During this process, noncondensable gases are stripped and routed to the gaseous waste management system, which consists of a series of gas storage tanks. The storage tanks allow the short-half-life radioactive gases to decay, leaving only relatively small quantities of long-half-life radionuclides to be released to the atmosphere. Some PWRs are using charcoal delay systems rather than gas storage tanks (e.g., Seabrook).

2.2.4.2 Liquid Radioactive Waste

Radionuclide contaminants in the primary coolant are the source of liquid radioactive waste in LWRs. The specific sources of these wastes, the modes of collection and treatment, and the types and quantities of liquid radioactive wastes released to the environment are in many respects similar in BWRs and PWRs. Accordingly, the following discussion applies to both BWRs and PWRs, with distinctions made only where important differences exist.

Liquid wastes resulting from LWR operation may be placed into the following categories: clean wastes, dirty wastes, detergent wastes, turbine building floor-drain water,[1] and steam generator blowdown (PWRs only). *Clean wastes* include all liquid wastes with a normally low conductivity and variable radioactivity content. They consist of reactor grade water, which is amenable to processing for reuse as reactor coolant makeup water. Clean wastes are collected from equipment leaks and drains, certain valve and pump seal leaks not collected in the reactor coolant drain tank, and other aerated leakage sources. These wastes also include primary coolant. *Dirty wastes* include all liquid wastes with a moderate conductivity and variable radioactivity content that, after processing, may be used as reactor coolant makeup water. Dirty wastes consist of liquid wastes collected in the containment building sump, auxiliary building sumps and drains, laboratory drains, sample station drains, and other miscellaneous floor drains. *Detergent wastes* consist principally of laundry wastes and personnel and equipment decontamination wastes and normally have a low radioactivity content. *Turbine building floor-drain wastes* usually have high conductivity and low radionuclide content. In PWRs, *steam generator blowdown* can have relatively high concentrations of radionuclides depending on the amount of primary-to-secondary leakage. Following processing, the water may be reused or discharged.

Each of these sources of liquid wastes receives varying degrees and types of treatment before storage for reuse or discharge to the environment under the site National Pollutant Discharge Elimination System (NPDES) permit. The extent and types of treatment depend on the chemical and radionuclide content of the waste; to increase the efficiency of waste processing, wastes of similar characteristics are batched before treatment.

The degree of processing, storing, and recycling of liquid radioactive waste has steadily increased among operating plants. For example, extensive recycling of steam generator blowdown in PWRs is now the typical mode of operation, and secondary side wastewater is routinely treated. In addition, the plant systems used to process wastes are often augmented with the use of commercial mobile processing systems. As a result, radionuclide releases in liquid effluent from LWRs have generally declined or remained the same.

2.2.4.3 Solid Radioactive Waste

Solid low-level radioactive waste (LLW) from nuclear power plants is generated by removal of radionuclides from liquid waste streams, filtration of airborne gaseous emissions, and removal of contaminated material from various reactor areas. Liquid contaminated with radionuclides comes from primary and secondary coolant systems, spent-fuel pools, decontaminated wastewater, and laboratory operations. Concentrated liquids, filter sludges, waste oils, and other liquid sources are segregated by type, flushed to storage tanks, stabilized for packaging in a solid form by dewatering, slurried into 55-gal steel drums, and stored on-site in shielded Butler-style buildings or other facilities until suitable for off-site disposal (NUREG/CR-2907). These buildings usually contain volume reduction facilities to reduce the volume of LLW requiring off-site disposal (EPRI NP-5526-V1).

High-efficiency particulate filters are used to remove radioactive material from gaseous plant effluents. These filters are compacted in volume reduction facilities that have volume reduction equipment and are disposed of as solid wastes.

Solid LLW consists of contaminated protective clothing, paper, rags, glassware, compactible and noncompactible trash, and non-fuel-irradiated reactor components and equipment. Most of this waste comes from plant modifications and routine maintenance activities. Additional sources include tools and other material exposed to the reactor environment (EPRI-NP-5526-V1; EPRI NP-5526-V2). Before disposal, compactible trash is usually taken to on- or off-site VR facilities. Compacted dry active waste is the largest single form of LLW disposed from nuclear plants, comprising one-half and one-third of total average annual volumes from PWRs and BWRs, respectively (EPRI NP-5526V1).

Volume reduction efforts have been undertaken in response to increased disposal costs and the passage of the 1980 Low Level Radioactive Waste Policy Act and the 1985 Low Level Radioactive Waste Policy Amendments Act (LLRWPAA) (Pub. L. 96-573; Pub. L. 99-240), which require LLW disposal allocation systems for nuclear plants (see Section 6.3). Volume reduction is performed both on- and off-site. The most common on-site volume reduction techniques are high-pressure compacting of waste drums, dewatering and evaporating wet wastes, monitoring waste streams to segregate wastes, minimizing the exposure of routine equipment to contamination, and decontaminating and sorting radioactive or nonradioactive batches before off-site shipment. Off-site waste management vendors compact compactible wastes at ultra-high pressure (supercompaction); incinerate dry active waste; separate and incinerate oily, organic wastes; solidify the ash; and occasionally undertake waste crystallization and asphalt solidification of resins and sludges

(EPRI NP-6163; EPRI NP-5526-V1; EPRI NP-5526-V2; DOE/RW-0220).

Spent fuel contains fission products and actinides produced when nuclear fuel is irradiated in reactors, as well as any unburned, unfissioned nuclear fuel remaining after the fuel rods have been removed from the reactor core. After spent fuel is removed from reactors, it is stored in racks placed in storage pools to isolate it from the environment. Delays in siting an interim monitored retrievable storage (MRS) facility or permanent repository, coupled with rapidly filling spent-fuel pools, have led utilities to seek other storage solutions, including expansion of existing pools, aboveground dry storage, longer fuel burnup, and shipment of spent fuel to other plants (Gerstberger 1987; DOE RW-0220).

Pool storage has been increased through (1) enlarging the capacity of spent-fuel racks, (2) adding racks to existing pool arrays ("dense-racking"), (3) reconfiguring spent fuel with neutron-absorbing racks, and (4) employing double-tiered storage (installing a second tier of racks above those on the pool floor).

Efforts are under way to develop dry storage technologies; these include casks, silos, dry wells, and vaults (DOE December 1989). Dry storage facilities are simpler and more readily maintained than fuel pools. They are growing in favor because they offer a more stable means of storage and require relatively little land area (less than 0.2 ha—half an acre in most cases) (Johnson 1989). Dry storage is currently in use at about 5 percent of the sites.

2.2.4.4 Transportation of Radioactive Materials

There are four types of radioactive material shipments to and from nuclear plants: (1) routine and refurbishment-generated LLW transported from plants to disposal facilities, (2) routine LLW shipped to off-site facilities for volume reduction, (3) nuclear fuel shipments from fuel fabrication facilities to plants for loading into reactors (generally occurring on a 12- to 18-month cycle), and (4) spent-fuel shipments to other nuclear power plants with available storage space (an infrequent occurrence usually limited to plants owned by the same utility).

Workers and others are protected from exposure during radioactive material transport by the waste packaging. Operational restrictions on transport vehicles, ambient radiation monitoring, imposition of licensing standards (which ensure proper waste certification by testing and analysis of packages), waste solidification, and training of emergency personnel to respond to mishaps are also used (NUREG-0170; O'Sullivan 1988). Additional regulations may be imposed by states and communities along transportation corridors (Pub. L. 93-633; OTA-SET-304).

A typical PWR makes approximately 44 shipments of LLW per year; an average BWR makes 104 shipments per year (EPRI NP-5983). Most of this LLW is Class A waste packaged in 55-gal drums or other "Type A" containers and shipped to disposal facilities on flatbed trucks (DOE August 1989). (A "Type A" container permits no release of radioactive material under normal transportation conditions and must maintain sufficient shielding to limit radiation exposure to handling personnel).

LLW shipments require manifests that describe the contents of the packages to permit inspection by state, local, and facility personnel and to ensure that the waste is suitable for a particular disposal facility (NUREG-0945).

Currently, the only spent-fuel shipments from nuclear plants are to other plants. A few spent-fuel shipments have, in the past, been made to fuel reprocessing plants. These shipments are packaged in "Type B" casks designed to retain the highly radioactive contents under normal and accident conditions. These containers range in size from 23–36 metric tons (25–40 tons) for truck shipment (each cask is capable of holding seven fuel assemblies) to 109 metric tons (120 tons) for rail transport (with a capacity for 36 assemblies) (DOE/RW-0065). The casks are resistant to both small-arms fire and high-explosive detonation (NUREG-0170).

2.2.5 Nonradioactive Waste Systems

Nonradioactive wastes from nuclear power plants include boiler blowdown (continual or periodic purging of impurities from plant boilers), water treatment wastes (sludges and high saline streams whose residues are disposed of as solid waste and biocides), boiler metal cleaning wastes, floor and yard drains, and stormwater runoff. Principal chemical and biocide waste sources include the following:

- Boric acid used to control reactor power and lithium hydroxide used to control pH in the coolant. (These chemicals could be inadvertently released because of pipe or steam generator leakage.)
- Sulfuric acid, which is added to the circulating water system to control scale.
- Hydrazine, which is used for corrosion control. (It is released in steam generator blowdown.)
- Sodium hydroxide and sulfuric acid, which are used to regenerate resins. (These are discharged after neutralization.)
- Phosphate in cleaning solutions.
- Biocides used for condenser defouling.

Other small volumes of wastewater are released from other plant systems depending on the design of each plant. These are discharged from such sources as the service water and auxiliary cooling systems, water treatment plant, laboratory and sampling wastes, boiler blowdown, floor drains, stormwater runoff, and metal treatment wastes. These waste streams are discharged as separate point sources or are combined with the cooling water discharges.

2.2.6 Nuclear Power Plant Operation and Maintenance

Nuclear power reactors are capable of generating electricity continuously for long periods of time. However, they operate neither at maximum capacity nor continuously for the entire term of their license. Plants can typically operate continuously for periods of time ranging from 1 year to 18 months on a single fuel load. Scheduled and unscheduled maintenance outages and less than peak power generation resulting from diminished consumer demand, or operational decisions, have reduced the power output for the U.S. nuclear power industry as a whole to an average annual capacity of between 58 and 73 percent of the maximum capability for the years 1975 through 1993, inclusive (NUREG-1350, vol. 6).

Maintenance activities are routinely performed on systems and components to help ensure the safe and reliable operation of the plant. In addition, inspection, testing, and surveillance activities are conducted throughout the operational life of a nuclear power plant to maintain the current licensing basis of the plant and ensure compliance with federal, state, and local requirements regarding the environment and public safety.

Nuclear power plants must periodically discontinue the production of electricity for refueling, periodic in-service inspection (ISI), and scheduled maintenance. Refueling cycles occur approximately every 12 to 18 months. The duration of a refueling outage is typically on the order of 2 months. Enhanced or expanded inspection and surveillance activities are typically performed at 5- and 10-year intervals. These enhanced inspections are performed to comply with Nuclear Regulatory Commission (NRC) and/or industry standards or requirements such as the American Society of Mechanical Engineers Boiler and Pressure Vessel Code. Five-year ISIs are scheduled for the 5th, 15th, 25th, and 35th years of operation, and 10-year ISIs are performed in the 10th, 20th, and 30th years. Each of these outages typically requires 2 to 4 months of down time for the plant. For economic reasons, many of these activities are conducted simultaneously (e.g., refueling activities typically coincide with the ISI and maintenance activities).

Many plants also undertake various major refurbishment activities during their operational lives. These activities are performed to ensure both that the plant can be operated safely and that the capacity and reliability of the plant remain at acceptable levels. Typical major refurbishments that have occurred in the past include replacing PWR steam generators, replacing BWR recirculation piping, and rebuilding main steam turbine stages. The need to perform major refurbishments is highly plant-specific and depends on factors such as design features, operational history, and construction and fabrication details. The plants may remain out of service for extended periods of time, ranging from a few months to more than a year, while these major refurbishments are accomplished. Outage durations vary considerably, depending on factors such as the scope of the repairs or modifications undertaken, the effectiveness of the outage planning, and the availability of replacement parts and components.

Each nuclear power plant is part of a utility system that may own several nuclear power plants, fossil-fired plants, or other means of generating electricity. An on-site staff is responsible for the actual operation of each plant, and an off-site staff may be headquartered at the plant site or some other location. Typically, from 800 to 2300 people are employed at nuclear power plant sites during periods of normal operation, depending on the number of operating reactors located at a particular site. The permanent on-site work force is usually in the range of 600 to 800 people per reactor unit. However, during outage periods, the on-site work force typically increases by 200 to 900 additional workers. The additional workers include engineering support staff, technicians, specialty craftspersons, and laborers called in both to perform specialized repairs, maintenance, tests, and inspections and to assist the permanent staff with the more routine activities carried out during plant outages.

2.2.7 Power-Transmission Systems

Power-transmission systems associated with nuclear power plants consist of switching stations (or substations) located on the plant site and transmission lines located primarily off-site. These systems are required to transfer power from the generating station to the utility's network of power lines in its service area.

Switching stations transfer power from generating sources to power lines and regulate the operation of the power system. Transformers in switching stations convert the generated voltage to voltage levels appropriate for the power lines. Equipment for regulating system operation includes switches, power circuit breakers, meters, relays, microwave communication equipment, capacitors, and a variety of other electrical equipment. This equipment meters and controls power flow; improves performance characteristics of the generated power; and protects generating equipment from short circuits, lightning strikes, and switching surges that may occur along the power lines. Switching stations occupy on-site areas generally two to four times as large as areas occupied by reactor and generator buildings, but are not as visible as the plant buildings.

The length of power transmission lines constructed for nuclear plants varies from a few miles for some plants to hundreds of miles for others. Power line systems include towers (structures), insulator strings, conductors, and ground wires strung between towers. Power lines associated with nuclear plants usually have voltages of 230 kV, 345 kV, 500 kV, or 765 kV (see Section 4.5.1). They operate at a low frequency of 60 Hz (60 cycles per second) compared with frequencies of 55–890 MHz for television transmitters and 1000 MHz and greater for microwaves.

Most power line towers are double wooden poles ("H-frame" structure) or metal lattice structures that support one or two sets of conductors (three conductors per set; see Section 4.5.1). Tower height, usually between 21 and 51 m (70 and 170 ft), increases with line voltage. Strings of insulators connect the conductors to the towers. The tops of the towers support two ground wires that transmit the energy of lightning strikes to the ground. Thus, the ground wires prevent lightning strikes to the conductors, minimize the occurrence of power system outages, and protect vital power system components that could be damaged by lightning-caused power surges on the conductors.

2.3 PLANT INTERACTION WITH THE ENVIRONMENT

This section describes how nuclear plants interact with the environment. Nuclear power plants are sited, designed, and operated to minimize impacts to the environment, including plant workers. Land that could be used for other purposes is dedicated to electric power production for the life of the plant. The aesthetics of the landscape are altered because of the new plant structures; the surface and groundwater hydrology and terrestrial and aquatic ecology may be affected; the air quality may be affected; and, finally, the community infrastructure and services are altered to accommodate the influx of workers into the area. The environmental impact from plant operation is determined largely by waste effluent streams (gaseous, liquid, and solid); the plant cooling systems; the exposure of plant workers to radiation; and plant expenditures, taxes, and jobs.

Operational activities associated with nuclear power plants, including maintenance actions, often produce liquid discharges that are released to the surrounding environment. The major liquid effluent occurs in once-through cooling systems which discharge heat and chemicals into a receiving body of water, but all nuclear power plants have liquid effluents to some extent. To operate, power plants must obtain an NPDES permit that specifies discharge standards and monitoring requirements, and they are required to be strictly in compliance with the limits set by the permit. NPDES permits are issued by the Environmental Protection Agency (EPA) or a designated state water quality agency. They must be renewed every 5 years.

Any gaseous effluents generated are similarly controlled by the EPA and state permitting agencies, which require compliance with the Clean Air Act and any amendments added by the states. On-site incineration of waste products is controlled in this manner.

2.3.1 Land Use

Nuclear power plants are large physical entities. Land requirements generally amount to several hundred hectares for the plant site, of which 20 to 40 ha (50 to 100 acres) may actually be disturbed during plant construction. Other land commitments can amount to many thousands of hectares for transmission line rights-of-way (ROWs) and cooling lakes, when such a cooling option is used.

Nuclear power plants that began initial operation after the promulgation of the National Environmental Policy Act of 1969 (Pub. L. 91-190) or the Endangered Species Act of 1973 (Pub. L. 93-205) are sited and operate in compliance with these laws. Any modifications to the plants after the effective dates of these acts must be in compliance with the requirements of these laws. The Endangered Species Act applies to both terrestrial and aquatic biota. The individual states may also have requirements regarding threatened and endangered species; the state-listed species may vary from those on the federal lists.

2.3.2 Water Use

Nuclear power plants withdraw large amounts of mainly surface water to meet a variety of plant needs (Section 2.2.3). Water withdrawal rates are large from adjacent bodies of water for plants with once-through cooling systems. Flow through the condenser for a 1,000-MW(e) plant may be 45 to 65 m^3/s (700,000 to 1,000,000 gal/min). Water lost by evaporation from the heated discharge is about 60 percent of that which is lost through cooling towers. Additional water needs for service water, auxiliary systems, and radioactive waste systems account for 1 to 15 percent of that needed for condenser cooling.

Water withdrawal from adjacent bodies of water for plants with closed-cycle cooling systems is 5 to 10 percent of that for plants with once-through cooling systems, with much of this water being used for makeup of water by evaporation. With once-through cooling systems, evaporative losses are about 40 percent less but occur externally in the adjacent body of water instead of in the closed-cycle system. The average makeup water withdrawals for several recently constructed plants having closed-cycle cooling, normalized to 1,000 MW(e), are about 0.9 to 1.1 m^3/s (14,000 to 18,000 gal/min). Variation results from cooling tower design, concentration factor of recirculated water, climate at the site, plant operating conditions, and other plant-specific factors.

Consumptive loss normalized to 1,000 MW(e) is about 0.7 m^3/s (11,200 gal/min), which is about 80 percent of the water volume taken in. Consumptive water losses remove surface water from other uses downstream. In those areas experiencing water availability problems, nuclear power plant consumption may conflict with other existing or potential closed-cycle uses (e.g., municipal and agricultural water withdrawals) and in-stream uses (e.g., adequate in-stream flows to protect aquatic biota, recreation, and riparian communities). The environmental impacts of consumptive water use are considered in Sections 4.2.1 and 4.2.2.

As discussed in Section 2.2.3, some nuclear power plants use groundwater as an additional source of water. The rate of usage varies greatly among users. Many plants use groundwater only for the potable water system and require less than 0.006 m^3/s (100 gal/min); however, withdrawals at other sites can range from 0.02 to 0.2 m^3/s (400 to 3000 gal/min). Impacts associated with groundwater use are discussed in Sections 4.2.2, 4.3.2, and 4.4.3.

Nuclear plant water usage must comply with state and local regulations. Most states require permits for surface water usage. Groundwater usage regulations vary considerably from state to state, and permits are typically required.

2.3.3 Water Quality

Water quality is impacted by the numerous nonradioactive liquid effluents discharged from nuclear power plants (Section 2.1.6). Discharges from the heat dissipation system account for the largest volumes of water and usually the greatest potential impacts to water quality and aquatic systems, although other systems may contribute heat and toxic chemical contaminants to the effluent. The relatively small volumes of water required for the service water and auxiliary cooling water systems do not generally raise concerns about thermal or chemical impacts to the receiving body of water. However, because effluents from these systems contain contaminants that could be toxic to aquatic biota, their concentrations are regulated under the power plant's NPDES discharge permit. The quality of groundwater may also be diminished by water from cooling ponds seeping into the underlying groundwater table.

Sewage wastes and cleaning solvents, including phosphate cleaning solutions, are treated as sanitary wastes. They are treated before release to the environment so that, after release, their environmental impacts are minimized. In cases where nonradioactive sanitary or other wastes cannot be processed by on-site water treatment systems, the wastes are collected by independent contractors and trucked to off-site treatment facilities. Water quality issues relate to the following: NPDES permit system for regulating low-volume wastewater, adequate wastewater treatment capacity to handle increased flow and loading associated with operational changes to the plant and discharges of wastes through emission of phosphates from utility laundries, suspended solids and coliforms from sewage treatment discharges, and other effluents that cause excessive biological oxygen demand.

Many power plants are periodically treated with biocidal chemicals (most commonly some form of chlorine) to control fouling and bacterial slimes. Discharge of these chemicals to the receiving body of water can have toxic effects on aquatic organisms. The biological and water quality impacts of discharges from the discharge systems are considered in Sections 4.2, 4.3, and 4.4.

Chlorine is used widely as a biocide at nuclear power plants and represents the largest potential source of chemically toxic release to the aquatic environment. Chlorine application as a cooling system biocide is typically by injection in one of several different forms, including chlorine gas or sodium hypochlorite. It may be injected at the intake or targeted at various points (such as the condensers) on an intermittent or continuous basis. Such treatments control certain pest organisms such as the Asiatic clam or the growth of bacterial or fungal slime (TVA 1978). The control of biological pests or growths is critical to maintaining optimum system performance and minimizing operating costs (EPRI CS-3748).

Because of the evolution of the guidelines pertaining to chlorine and changes in biocide technologies over the past 15 years, the potential for any adverse impacts of chlorine has been decreasing. Improvements in dechlorination technologies are likely to significantly reduce the level of chlorine in the aquatic environment. Given the critical need for controlling biofouling in the cooling system, both alternative and chlorine treatment technologies are expected to keep pace with regulatory requirements.

All effluent discharges are regulated under the provisions of the Clean Water Act and the implementing effluent guidelines, limitations, and standards established by EPA and the states. Conditions of discharge for each plant are specified in its NPDES permit issued by the state or EPA.

2.3.4 Air Quality

Transmission lines have been associated with the production of minute amounts of ozone and oxides of nitrogen. These issues are associated with corona, the breakdown of air very near the high-voltage conductors. Corona is most noticeable for the higher-voltage lines and during foul weather. Through the years, line designs have been developed that greatly reduce corona effects.

The effluents created and released from the incineration of any waste products must comply with EPA and state requirements regarding air quality. Permits for release of controlled amounts of these effluents to the atmosphere are controlled by state permitting agencies. Because nuclear power plants generally do not produce gaseous effluents, the impact on air quality is minimal.

2.3.5 Aquatic Resources

Operation of the once-through (condenser cooling) system requires large amounts of water that are withdrawn directly from surface waters. These surface waters contain aquatic organisms that may be injured or killed through their interactions with the power plant. Aquatic organisms that are too large to pass through the intake debris screens, which commonly have a 1-cm (0.4-in.) mesh, and that cannot move away from the intake, may be impinged against the screens. If the organisms are held against the screen for long periods, they will suffocate; if they receive severe abrasions, they may die. Impingement can harm large numbers of fish and large invertebrates (e.g., crabs, shrimp, and jellyfish).

Aquatic organisms that are small enough to pass through the debris screens will travel through the entire condenser cooling system and be exposed to heat, mechanical, and pressure stresses, and possibly biocidal chemicals, before being discharged back to the body of water. This process, called entrainment, may affect a wide variety of small plants (phytoplankton), invertebrates (zooplankton), fish eggs, and larvae (ichthyoplankton). Entrainment mortality is variable. Conditions at some plants with once-through cooling may result in relatively low levels of mortality, although at such plants the volumes of water (and numbers of entrained organisms) are often high. On the other hand, generally no aquatic organisms survive at plants with closed-cycle cooling that recirculate water through cooling towers, although the volumes of water withdrawn are relatively low. Biological effects of entrainment and impingement are considered in Section 4.2.3.

Discharges from the plant heat rejection system may affect the receiving body of water through heat loading and chemical contaminants, most notably chlorine or other biocides. Heated effluents can kill aquatic organisms directly by either heat shock or cold shock. In addition, a number of indirect or sublethal stresses are associated with thermal discharges that have the potential to alter aquatic communities (e.g., increased incidence of disease, predation, or parasitism, as well as changes in dissolved gas concentrations).

As stated in Section 2.3.3, all effluent discharges are regulated by the Clean Water Act and standards established by the EPA and the individual states. Conditions of discharge for each plant are specified in the NPDES permit issued for that plant.

2.3.6 Terrestrial Resources

A number of ongoing issues associated with terrestrial resources can arise in the immediate area around the plant or its power transmission lines. Most power lines are located on easements (or ROWs) that the utility purchased from the landowner. Land uses on the easements are limited to activities compatible with power-line operation. In areas with rapidly growing vegetation, utilities must periodically cut or spray the vegetation to prevent it from growing so close to the conductors that it causes short circuits and endangers power line operation. Other terrestrial resource issues can result from changes in local hydrology. Such changes can occur from altered contouring of the land, reduced tree cover, and increased paving. These changes can reduce the value of land and contribute to local erosion and flooding. Additional impacts can include the effects of cooling tower effluent drift, reduced habitat for plants and animals, disruption of animal transit routes, and bird collisions with cooling towers and transmission lines.

Each plant planning to apply for license renewal will need to consult with the appropriate agency administering the Endangered Species Act of 1973 about the presence of threatened or endangered species. Compliance with the Endangered Species Act will be a necessary part of each plant's environmental documentation at the time of license renewal.

2.3.7 Radiological Impacts

2.3.7.1 Occupational Exposures

Plant workers conducting activities involving radioactively contaminated systems or working in radiation areas can be exposed to radiation. Most of the occupational radiation dose to nuclear plant workers results from external radiation exposure rather than from internal exposure from inhaled or ingested radioactive materials. Experience has shown that the dose to nuclear plant workers varies from reactor to reactor and from year to year. Since the early 1980s, when NRC regulatory requirements and guidance placed increased emphasis on maintaining nuclear power plant occupational radiation exposures as low as reasonably achievable, there has been a decreasing trend in the average annual dose per nuclear plant worker.

The effect of plant refurbishment on occupational doses is evaluated in Sections 3.8.2 and in Appendix B. Similarly, the effect of continued operation associated with license renewal on occupational doses is evaluated in Section 4.6.3.

2.3.7.2 Public Radiation Exposures

Commercial nuclear power reactors, under controlled conditions, release small amounts of radioactive materials to the environment during normal operation. These releases result in radiation doses to humans that are small relative to doses from natural radioactivity. Nuclear power plant licensees must comply with NRC regulations (e.g., 10 CFR Part 20, Appendix I to 10 CFR Part 50, 10 CFR Part 50.36a, and 40 CFR Part 190) and conditions specified in the operating license.

Potential environmental pathways through which persons may be exposed to radiation originating in a nuclear power reactor include atmospheric and aquatic pathways. Radioactive materials released under controlled conditions include fission products and activation products. Fission product releases consist primarily of the noble gases and some of the more volatile materials like tritium, isotopes of iodine, and cesium. These materials are monitored carefully before release to determine whether the limits on releases can be met. Releases to the aquatic pathways are similarly monitored. Radioactive materials in the liquid effluents are processed in radioactive waste treatment systems (Section 2.2.4). The major radionuclides released to the aquatic systems are tritium, isotopes of cobalt, and cesium.

When an individual is exposed through one of these pathways, the dose is determined in part by the exposure time, and in part by the amount of time that the radioactivity inhaled or ingested is retained in the individual's body. The major exposure pathways include the following:

- inhalation of contaminated air,
- drinking milk or eating meat from animals that graze on open pasture on which radioactive contamination may be deposited,
- eating vegetables grown near the site, and
- drinking (untreated) water or eating fish caught near the point of discharge of liquid effluents.

Other less important exposure pathways include external irradiation from surface deposition; consumption of animals that drink irrigation water that may contain liquid effluents; consumption of crops grown near the site using irrigation water that may contain liquid effluents; shoreline, boating, and swimming activities; and direct off-site irradiation from radiation coming from the plant.

Radiation doses to the public are calculated in two ways. The first is for the maximally exposed person (that is, the real or hypothetical individual potentially subject to maximum exposure). The second is for average individual and population doses. Doses are calculated using site-specific data where available. For those cases in which site-specific data are not readily available, conservative (overestimating) assumptions are used to estimate doses to the public.

2.3.7.3 Solid Waste

Both nonradioactive and radioactive wastes are generated at nuclear power plants. The nonradioactive waste is generally not of concern unless it is classified as Resource Conservation and Recovery Act (RCRA) waste. All waste that is hazardous, that is, classified as RCRA waste, is packaged and disposed of in a licensed landfill consistent with the provisions of RCRA.

Hazardous chemicals, properly handled and controlled, do not present a major health risk to personnel at nuclear power plants, but they must be understood and treated carefully. Hazardous chemicals may be encountered in the work environment during adjustments to the chemistry of the primary and secondary coolant systems, during biocide application for fouling of heat removal equipment, during repair and replacement of equipment containing hazardous oils or other chemicals, in solvent cleaning, and in the repair of equipment. Exposures to hazardous chemicals are minimized by observing good industrial hygiene practices. Disposal of essentially all of the hazardous chemicals used at nuclear power plants is regulated by RCRA or NPDES permits.

Solid radioactive waste consists of LLW, mixed waste, and spent fuel. LLW is generated by removal of radionuclides from liquid waste streams, filtration of airborne gaseous emissions, and removal of contaminated material from the reactor environment.

Mixed waste is LLW that contains chemically hazardous components as defined under RCRA. Mixed waste consists primarily of decontamination wastes and ion exchange resins. The volume of mixed wastes produced at nuclear power plants is typically a small fraction of their overall waste stream, accounting for less than 3 percent by volume of the annual LLW discharged.

Spent fuel is produced during reactor operations. The buildup of fission products and actinides during normal operation prevents the continued use of the fuel assembly. Spent fuel is stored at the reactor site. Uncertainty exists as to when an MRS or permanent spent-fuel repository may become available. However, NRC has examined this issue and determined that licensees may, without significant impact on the environment, store spent fuel on-site for 80 years after ceasing reactor operation (55 FR 38474).

Four major considerations must be addressed when managing solid radioactive waste: (1) the adequacy of interim storage on-site in lieu of permanent off-site disposal, (2) transport of the radiological wastes to disposal sites over the nation's highways and railways, (3) worker and public radiation exposure resulting from handling and processing operations and transportation, and (4) final disposal.

LLW is normally temporarily stored on-site before being shipped to licensed LLW disposal facilities. Previously these facilities were at Barnwell, South Carolina; Beatty, Nevada; and Hanford, Washington. Under the Low Level Radioactive Waste Policy Act of 1980 and the LLRWPAA of 1985, states must secure their own disposal capacity for LLW generated within their boundaries after 1992 by forming waste compacts that are responsible for siting regional disposal facilities, or by siting their own disposal facilities.

For disposal purposes, mixed waste is principally regulated by NRC (10 CFR Part 61). Although the LLRWPAA of 1985 required states to certify they are capable of providing storage and disposal of mixed wastes in an NRC/EPA-licensed facility by 1992, there are currently no licensed disposal facilities accepting commercially generated mixed waste. Because these facilities are not yet available, mixed waste is currently stored on-site.

Originally, disposal of spent fuel in a deep-geological repository was contemplated. However, because of delays in siting a permanent repository on the part of the Department of Energy and delays in developing an interim MRS facility, as required by the Nuclear Waste Policy Act of 1982, nuclear power plants are storing their spent fuel on-site.

LLW is compacted and packaged, typically in 55-gal drums, then transported via truck or railcar. The packaging and transportation of both LLW and mixed waste must comply with EPA requirements. NRC specifications for reviewing the environmental effects of the transport of spent fuel are contained in the Table S-4 Rule (54 FR 187; 10 CFR Part 51.52). States and communities along transportation corridors may impose additional restrictions on the transport of nuclear waste.

Workers receive radiation exposure during the storage and handling of radioactive waste and during the inspection of stored radioactive waste. However, this source of exposure is small compared with other sources of exposure at operating nuclear plants. Members of the general public are also exposed when the LLW is shipped to a disposal site. No other type of radioactive waste is currently being transported from the reactor sites. The public radiation exposures from radioactive material transportation have been addressed generically in Table S-4 of 10 CFR Part 51. Table S-4 indicates that the cumulative dose to the exposed public from the transport of both LLW and spent fuel is estimated to be about 0.03 person-sievert (3 person-rem) per reactor year.

2.3.8 Socioeconomic Factors

2.3.8.1 Work Force

Although the size of the work force varies considerably among U.S. nuclear power plants, the on-site staff responsible for operational activities generally consists of 600 to 800 personnel per reactor unit. The average permanent staff size at a nuclear power plant site ranges from 800 to 2400 people, depending on the number of operating reactors at the site. In rural or low population communities, this number of permanent jobs can provide employment for a substantial portion of the local work force. Table 2.3 depicts mean employment during normal operations in the 1975–1990 period, grouped by the number of reactors.

In addition to the work force needed for normal operations, many nonpermanent personnel are required for various tasks that occur during outages, for example, refueling outages, ISIs, or major refurbishments. Between 200 and 900 additional workers may be employed during these outages to perform the normal outage maintenance work. These are work force personnel who will be in the local community only a short time, but during these periods of extensive maintenance activities, the additional personnel will have a substantial effect on the locality. Table 2.4 indicates the levels of additional personnel typically required for different types of outages.

A substantial portion of the regular plant work force is normally involved in many of the efforts listed in Table 2.4, supplemented as needed by contractor personnel for support during specialized projects. Peak crew sizes are greatly affected by the specific requirements at each plant, utility decisions to make major repairs to systems and components to improve or sustain plant performance, and the relative phasing (schedule overlap) of these activities. Exact crew sizes can, therefore, vary widely from plant to plant.

2.3.8.2 Community

Typically, the immediate environment in which a nuclear power plant is located is rural, but the population density of the larger area surrounding the plant and the distance from a medium- or large-sized metropolitan center varies substantially across sites. Most sites, however, are not extremely remote [i.e., not more than about 30 km (20 miles) from a community of 25,000 or 80 km (50 miles) from a community of 100,000]. The significance of any given nuclear power plant to its host area will depend to a large degree on its location, with the effects generally being most concentrated in those communities

Table 2.3 Changes in mean operations-period employment at nuclear power plants over time

Operations period	One-unit plants[a]	Two-unit plants[a]	Three-unit plants[a]
Current[b]	832 (34)	1247 (28)	2404 (4)
1985-1989	841 (30)	1094 (26)	2095 (4)
1980-1984	447 (19)	946 (21)	1078 (3)
1975-1979	233 (17)	515 (16)	699 (3)

[a]Number in parentheses indicates number of plants providing data.
[b]Approximately half the respondents reported data for 1989 and half for 1990.

Table 2.4 Mean additional employment per reactor unit associated with three outage types at nuclear power plants

Outage type[a]	Number of workers
Typical planned (58)	783
In-service inspection (23)	734
Largest single (45)	1148

[a]Number in parentheses indicates number of plants providing data for the survey (NUMARC).

closest to the plant. Major influences on the local communities include the plant's effects on employment, taxes, housing, off-site land use, economic structure, and public services.

As noted in Section 2.3.8.1, the average nuclear power plant directly employs 800 to 2400 people. Many hundreds of additional jobs are provided through plant subcontractors and service industries in the area. In rural communities, industries that provide this number of jobs at relatively high wages are major contributors to the local economy. In addition to the beneficial effect of the jobs that are created, local plant purchasing and worker spending can generate considerable income for local businesses.

Nuclear power plants represent an investment of several billion dollars. Such an asset on the tax rolls is extraordinary for rural communities and can constitute the major source of local revenues for small or remote taxing jurisdictions. Often, this revenue can allow local communities to provide higher quality and more extensive public services with lower tax rates. In general, capital expenditures and large changes in public services are seldom necessitated by the presence of the plant and its operating workers, particularly after local communities have adapted to greater and more dynamic changes experienced during plant construction.

As this discussion indicates, nuclear power plants can have a significant positive effect on their community environment. These effects are stable and long term. Because these socioeconomic effects generally enhance the economic structure of the local community, nuclear power plants are accepted by the community, and indeed, become a major positive contributor to the local environs.

2.4 LICENSE RENEWAL—THE PROPOSED FEDERAL ACTION

This section provides a brief overview of the most significant requirements of the proposed revision to 10 CFR Part 54, "Nuclear Power Plant License Renewal" (FR 59, no. 174, p. 46574).

Under the license renewal rule (10 CFR Part 54), nuclear power plant licensees would be allowed to operate their plants for a maximum of 20 years past the terms of their original 40-year operating licenses provided that certain requirements are met (Section 1.1). The rule requires licensees submitting license renewal applications to perform specified types of evaluations and assessments of their facilities, and to provide sufficient information for the NRC to determine whether continued operation of the facility during the renewal term would endanger public safety or the environment.

License renewal will be based on ensuring plant compliance with its current licensing basis (i.e., the original plant licensing basis as amended during the initial license term). In addition, licensees will be required to demonstrate for certain important systems, structures, and components (SSCs) that the effects of aging will be managed in the renewal period in a manner so that the important functions of these SSCs will be maintained. The SSCs of concern in the renewal period are those which traditionally do not have readily monitorable performance or condition characteristics and include most passive, long-lived plant SSCs. Therefore, the NRC's license renewal rule requires a systematic review of, at least, passive, long-lived SSCs that support safety or other critical functions of a nuclear power plant (as delineated in the rule). To make these determinations regarding these SSCs, it is expected that licensees will implement aging management activities for SSCs for which current programs may not be adequate to ensure continued functionality in the renewal term. These aging management activities are expected to include surveillance, on-line monitoring, inspections, testing, trending, repair, refurbishment, replacement, and recordkeeping, as appropriate.

The license renewal rule seeks to ensure that the effects of aging in the period of extended operation are adequately managed. The rule allows credit for existing programs and regulatory requirements that continue to be applicable in the period of extended operation and that provide adequate management of the effects of aging for SSCs. This provision includes credit for rules or requirements, such as those incorporated in the maintenance rule, which could impact license renewal activities performed to detect and mitigate age-related functionality degradation.

The rule requires an integrated plant assessment (IPA). License renewal applicants must perform an IPA to determine which SSCs will be subject to additional review. The IPA would then determine whether additional programs, over and above the current operational and maintenance programs, are required to manage the effects of aging so that equipment function is maintained.

In addition, the license renewal rule requires licensees submitting an application for license renewal to provide the following:

- information noting any changes in the current licensing basis that occur during NRC's review of the submittal; and
- an evaluation of time-limited aging analyses (i.e., issues such as fatigue, equipment qualification, and reactor-vessel neutron embrittlement which have inherent time limits associated with them).

Key aspects of 10 CFR Part 54 could result in environmental impacts because of the requirements imposed. These key aspects are (1) the enhanced surveillance, on-line monitoring, inspections, testing, trending, and recordkeeping (SMITTR) on SSCs identified in the IPA and (2) the resulting actions taken to ensure that aging would be effectively managed and that the functionality of these SSCs would be maintained throughout the term that the new license would be in effect.

Note that the license renewal rule does not require any specific repairs, refurbishments, or modifications to nuclear facilities, but only that appropriate actions be taken to ensure the continued functionality of SSCs in the scope of the rule.

2.5 BASELINE ENVIRONMENTAL IMPACT INITIATORS ASSOCIATED WITH CONTINUED OPERATION OF NUCLEAR POWER PLANTS

The previous sections identified the various types of environmental impacts associated with current nuclear power plant operation. Before discussing incremental impacts associated with license renewal, it is useful to first establish a baseline from which to evaluate incremental effects. This baseline is provided by current experience with nuclear power plant operation and the related interactions with the environment. This section presents quantitative information on selected environmental "impact initiators." The term "impact initiators" is defined, followed by estimates of the quantities of each initiator currently generated by typical nuclear power plant operation.

2.5.1 Definition of Environmental Impact Initiators

The terms "environmental impact initiators" and "impact initiators" as used here refer to the precursors to possible environmental impacts. For example, the incremental work force needed to accomplish license renewal activities is not an environmental impact, but the associated effects on housing, transportation, schools, etc., are environmental or socioeconomic impacts. The environmental impact initiators that need to be quantified to estimate overall environmental effects resulting from license renewal are as follows:

- Labor hours and work force size associated with on-site craft workers, engineering and administrative personnel, and health physics personnel are needed to estimate socioeconomic impacts to communities affected by personnel employed temporarily at nuclear plants.
- Labor costs are used to estimate both economic impacts to affected communities and economic viability of extended plant operation through license renewal.
- Occupational radiation exposure is used to estimate radiation-related impacts to workers.
- Capital costs of hardware, materials, and equipment are used both to estimate tax-base-related impacts to affected communities and to provide information related to the overall economics of license renewal.
- Radioactive waste types, volumes, and disposal costs are used to estimate environmental impacts related to the disposal of such wastes.

These impact initiators are the key elements expected to change, relative to current nuclear plant operation, as a result of actions taken to support license renewal. Other environmental considerations, including water usage, land usage, chemical usage/discharges, and air quality, are not anticipated to change significantly as a result of license renewal activities.

The impact initiators assessed—labor force, labor costs, capital costs, occupational radiation exposure, and radioactive waste volumes—help determine most of the potential changes in environmental impacts resulting from license renewal. For example, estimates of refurbishment labor and capital cost, together with a description of the types of refurbishment activities that might be undertaken, help define potential environmental impacts related to refurbishment period land use, water use, air quality, socioeconomics, nonradiological solid wastes, etc. The impact initiators assessed form a sufficient set from which to assess most license renewal-related environmental impacts. Also, the focus is on changes in impact initiators originating from plant activities, as opposed to changes in the plant environs or receptors (e.g., changes in the population affected by the plant).

2.5.2 Baseline Environmental Impact Initiator Estimates

The following discussions provide estimates of the baseline quantities for each of the foregoing impact initiators. These baseline quantities are typical of current nuclear plant operation.

2.5.2.1 Baseline Work Force Size and Expenditures for Labor

Table 2.3 indicates that the current work force at nuclear plant sites is typically in the range of 830 to 2400 permanent staff, depending on the number of operating reactors at a site. On-site personnel responsible for operational activities generally number between 600 and 800 per reactor unit. The average number of permanent staff per reactor unit is estimated to be about 700 people, and this number is approximately the same for both BWRs and PWRs. Assuming a normal 40-hour work week for most on-site staff, this staffing translates into an annual labor effort of about 1.5 million labor hours per unit. The permanent staff is augmented by temporary workers called in to assist with outage activities and special projects. The associated expenditures for labor, including an allowance of roughly 20 percent for temporary staff to support outages and special projects, is estimated to be about $77,000,000 annually per unit.

2.5.2.2 Baseline Capital Expenditures

Nuclear power plants incur expenditures for three major types of capital additions. There are (1) major plant retrofits needed to satisfy NRC requirements to ensure safe plant operation (e.g., changes required as a result of resolution of a generic safety issue), (2) major repairs needed to keep the plant operational (such as main turbine-generator repairs), and (3) discretionary activities undertaken to improve plant performance and labor productivity (DOE/EIA-0547). Expenditures for capital additions have varied widely from plant to plant and from one year to another. In 1989, the average expenditure for capital additions was about $24 per kilowatt, or roughly $24 million for a 1000-MW(e) plant (1989 dollars). These expenditures equate to about $28 million per year per 1000-MW(e) plant in 1994 dollars.

2.5.2.3 Baseline Occupational Radiation Exposure

Occupational radiation exposures vary considerably from plant to plant and from year to year at a given plant. The long-term trends indicate that overall worker exposure has been decreasing on a per-plant basis. The average occupational exposure for the year 1989 was roughly 4.4 person-sievert (440 person-rem) per plant at BWRs and about 3 person-sievert (300 person-rem) per plant at PWRs. For the years 1991 to 1993, the average exposure for all U.S. nuclear plants was about 2.5 person-sievert (250 person-rem) per plant (NUREG-1350, v.6). Significant deviations from these averages are routinely experienced, depending largely on whether a given plant had an outage during a given year and the nature and extent of refurbishment or repair activities undertaken during outages.

2.5.2.4 Baseline Radioactive Waste Generation

Section 2.2.4.3 discussed the different types of radioactive wastes typically generated at nuclear power plants. The type of waste generated in the greatest volumes is LLW. The volume of LLW disposed of annually has shown a decreasing trend over the past several years. Most recently, the amount of LLW disposed of at PWRs has been about 250 m^3/year (8800 ft^3/year); in contrast, the amount disposed of at BWRs has been about 560 m^3/year (19,700 ft^3/year).

Small volumes of mixed wastes are also generated by nuclear plant operation. However, any such waste that cannot be treated to eliminate the chemical hazards is currently stored on-site at the nuclear plants and not shipped for disposal.

U.S. reactors generate high-level wastes, primarily in the form of spent fuel. The quantities of spent fuel generated on a per-reactor-year basis is not expected to change with license renewal.

2.6 ENVIRONMENTAL IMPACT INITIATORS ASSOCIATED WITH LICENSE RENEWAL AND CONTINUED OPERATION

2.6.1 Scope and Objectives of Section 2.6

A major objective of the GEIS is to support the proposed changes to 10 CFR Part 51 by defining the issues that need to be addressed by the NRC and the applicants in plant-specific license renewal proceedings. First, the environmental issues are defined by characterizing and evaluating the actions and activities that may be undertaken by licensees in pursuit of license renewal and extended plant life. These actions and activities are then used to characterize their associated potential environmental impacts.

This section discusses potential actions nuclear power plant licensees may undertake to achieve license renewal and an extended plant life. This section also estimates the extent of the environmental initiators associated with these actions during license renewal and the extended term of operation.

The preceding section noted that the license renewal rule requires that the functionality of important SSCs be maintained throughout the period of the renewed license. To provide this assurance, licensees will likely undertake enhanced SMITTR activities on SSCs identified in the IPA and, based on the findings of these efforts, take appropriate action to ensure that aging is effectively managed and that the functionality of these SSCs is maintained. Incremental repair, refurbishment, and/or replacement of SSCs, as well as related changes to plant operations and maintenance, may be performed to ensure that this objective is achieved. These actions, either directly or indirectly, will produce incremental impacts to the local environment. These incremental effects are over and above those expected if plants were simply to continue to operate as at present.

Licensees may also choose to undertake various refurbishment and upgrade activities at their nuclear facilities to better maintain or improve reliability, performance, and economics of power plant operation during the extended period of operation. These are activities which would be performed at the option of the licensee and which are in addition to those performed to satisfy the license renewal rule requirements.

The set of activities undertaken is expected to vary widely from plant to plant. Some plants may require little refurbishment and upgrading. Other plants may require considerable refurbishment and upgrading. For purposes of the GEIS, two types of license renewal programs were considered for which the environmental impact initiators were developed:

- a "typical" or "mid-stream" license renewal program, intended to be representative of the type of program that many plants seeking license renewal might implement, and
- a "conservative" or "bounding" program encompassing considerably more activities by licensees, intended to characterize an upper bound, or near upper bound, of the impacts that could be generated at a nuclear power plant.

Each program applies to both BWRs and PWRs. Thus, there are four separate cases or scenarios considered: a typical BWR, an upper bound or conservative BWR, a typical PWR, and a conservative PWR.

The typical scenarios can be used to estimate environmental impacts from an "average" license renewal program and to estimate the nationwide impacts of the total nuclear power plant population. The bounding license renewal scenarios, being much more conservative, are intended to address what might occur for those plants whose impacts will be considerably greater than is typical of the nuclear power reactor population as a whole.

Section 2.6.2 presents the bases and assumptions used in developing the different license renewal scenarios. Section 2.6.3 describes and characterizes the typical license renewal scenarios and the resulting environmental impact initiators. The conservative scenario program is described in Section 2.6.4.

2.6.2 Bases, Assumptions, and Approach

2.6.2.1 Structures, Systems, and Components of Interest

The SSCs of interest for assessing license renewal-related environmental impacts are those that are critical to the safe operation of the plant and that traditionally do not have readily monitorable performance characteristics, which means that the effects of aging may go undetected and lead to the loss of SSC functionality. Many structures and components in currently-licensed LWRs are subject to programs such as the maintenance rule, periodic surveillances, and periodic replacement and refurbishment and have readily monitorable performance or condition characteristics so that these programs can reveal the effects of aging in sufficient time to prevent loss of SSC functionality. However, many other nuclear plant components, such as passive, long-lived structures and components, may not be subject to programs which reveal the effects of aging in sufficient time to ensure their functionality. Therefore, these passive, long-lived structures and components are the items that may need new or incremental aging management activities. The SSCs used in the current evaluation are discussed in Sections 2.6.3.1 and 2.6.4.1 for the typical and conservative programs, respectively.

2.6.2.2 Definition of Candidate Aging Management Activities

A comprehensive list of possible license renewal-related activities with potential environmental impacts was developed. Emphasis was placed on defining those activities clearly associated with license renewal, that is, those activities which would not be included in a continuation or extrapolation of the activities that occurred during the original licensing term. The types of activities considered ranged from enhanced inspection programs to component replacement. In turn, the potential environmental impacts of each identified activity were examined and analyzed.

Following the identification of candidate SSCs and the related aging management activities for each of the different license renewal programs, quantitative estimates of potential environmental impact initiators were developed. The estimates apply to a particular approach to aging management.

The data needed to characterize aging management activities were developed in the context of the four major license renewal programs previously identified: a typical BWR, a conservative BWR, a typical PWR, and a conservative PWR. Each program consisted of the following:

- lists of SSCs for which incremental activities would be performed to ensure that safe and economical operation could be achieved throughout the extended life of the plant;
- lists of the activities performed on each SSC to manage aging;
- the number of times each activity would be performed, accounting for repetitive actions on individual SSCs and the number of similar items in the plant subject to these activities; and
- the specific times during which each activity is performed.

The generic license renewal programs utilized in this evaluation were based on similar schedules for carrying out the selected aging management activities. Any major refurbishment work called for by the programs was assumed to start shortly after a renewed license had been granted. In these example programs, this would occur in roughly year 30 of the original 40-year license term. This work was assumed to be completed over several successive outages, including one at the end of the 40th year of plant operation. Incremental SMITTR actions, and the installation of enhanced or additional surveillance and monitoring equipment and systems, were also assumed to be initiated at this time. The SMITTR actions continue throughout the remaining life of the plants. This is true for both the typical and conservative case scenarios.

2.6.2.3 Incremental Effects Only

All aging management programs of interest to the current effort deliberately omit, to the extent possible, current practice as it has evolved and is expected to evolve in the license renewal period. The programs also exclude any changes in the basic design or technology of the plant. Rather, they include only those activities that would constitute a discrete change in the plant's operation and maintenance program and would be implemented only after issuance of the renewal license. In particular, all normal repair activities, as well as any activities undertaken to satisfy recently enacted requirements such as the Maintenance Rule, are considered to fall within the scope of current practice and were excluded from consideration. Therefore, the impact initiators considered here are incremental to those resulting from the extension of current practice.

2.6.2.4 Reference Plant Size and Characteristics

All assessments presented here reflect design features and quantities consistent with 1000-MW(e) plant designs. For the PWRs, the features and sizing chosen were consistent with those for a four-loop Westinghouse plant design with a large dry containment. The BWR features used were representative of designs utilizing internal jet pumps and two recirculation loops. Mark III containment features were used.

2.6.2.5 Reference SMITTR Program

The generic BWR and PWR aging management programs used in the present evaluations for both the typical and conservative scenarios were based on the safety-centered SMITTR programs that were used in the regulatory analysis for 10 CFR Part 54 (NUREG-1362). These basic SMITTR programs were supplemented by activities planned for the Lead Plant programs (Sciacca 1/3/93 and Sciacca 1/13/93). In addition, the aging management programs used as the basis for the current impact initiator estimates included actions anticipated for non–safety-related systems and equipment, but which licensees may undertake to maintain or enhance plant availability and performance. The conservative case scenarios, in particular, assumed considerable expansion of the basic Part 54 programs to include actions on many balance-of-plant SSCs. The inclusion of activities directed toward non–safety-related SSCs considerably expanded the number of times given activities would be performed and significantly increased the variety of activities performed, compared with those considered for the 10 CFR Part 54 Regulatory Analysis. The inclusion of aging management activities beyond those characterized for safety-centered SMITTR programs enhances the comprehensiveness and conservatism of the estimates used in the preparation of the GEIS conservative cases. The typical license renewal program scenarios also include more SMITTR actions than those used for the 10 CFR Part 54 assessments, but to a lesser degree than the conservative case scenarios. The typical program SMITTR activities incremental to those anticipated under Part 54 were included to allow for voluntary actions on the part of licensees to better manage aging of balance-of-plant SSCs. All typical program activities were reviewed for possible overlap with the Maintenance Rule activities; any activities perceived to fall within the scope of the Maintenance Rule or other rules were eliminated from the programs.

2.6.2.6 Major Refurbishments and Replacements

The major refurbishment/replacement class of activities included in the license renewal programs characterized here is intended to encompass actions which typically take place only once in the life of a nuclear plant, if at all. Replacement of BWR recirculation piping and PWR steam generators falls into this category of activities. Many such activities were included in the conservative case license renewal scenarios. The items making up this category include both activities which have already been performed at some operating LWRs and activities which have not yet been performed, at least not to the extent assumed for the purpose of defining potential environmental impacts. The inclusion of activities which have already been performed on some existing nuclear plants is based on the premise that there are certain plants in the reactor population that will not have to perform these activities during the current license term, but that would elect to perform these major activities to enable safe and economic operation for the incremental term allowed with license renewal. In addition, major refurbishment activities included in these example license renewal programs encompass all areas of a nuclear power plant (e.g., structures, mechanical and electrical systems, fluid systems). This approach further ensures that the impacts characterized for the conservative case scenarios have a high probability of bounding the impacts likely to accrue to any individual plant seeking license renewal and extended plant operation.

The typical scenarios, in contrast, included fewer major refurbishment activities of this type. For these scenarios the assumption was made that most plants will have ongoing effective maintenance and refurbishment programs that preclude the need for refurbishment/replacement of all but a few components and structures.

2.6.2.7 Prototypic License Renewal Schedule

Figure 2.3 shows representative timelines for the license renewal process of a nuclear plant. The timelines shown were judged to be reasonable by the NRC staff. The schedule is applicable to both the typical and conservative license renewal scenarios. The upper timeline shows the relationship of the new license period to the initial license period. The lower line indicates the various outage types and their assumed timing over the period covered by a renewed license. The key underlying assumption for the timelines is that the licensee should be assured by the NRC 10 years before the expiration of its current operating license that the plant in question is suitable for license renewal. These 10 years are required for the licensee to arrange for alternative sources of power should a renewed license not be granted. The license renewal process is presumed to start with the licensee initiating a number of studies and analyses to support the license renewal application 3 years before submitting the application to the NRC. The NRC would then perform a detailed review of the application and, in the successful cases, issue a new license (with conditions) within 2 years after the application is received. The new license would go into effect at that point, covering the balance of the original 40-year term, as well as the additional 20-year term.

It was assumed that licensees would initiate incremental aging detection and management activities as soon as the new license was granted, as called for by 10 CFR Part 54. Discretionary major refurbishment activities might also be undertaken early into the license renewal term.

2.6.2.8 Schedule for Performing Major Refurbishment Activities

The reference schedule assumes that major refurbishment activities associated with

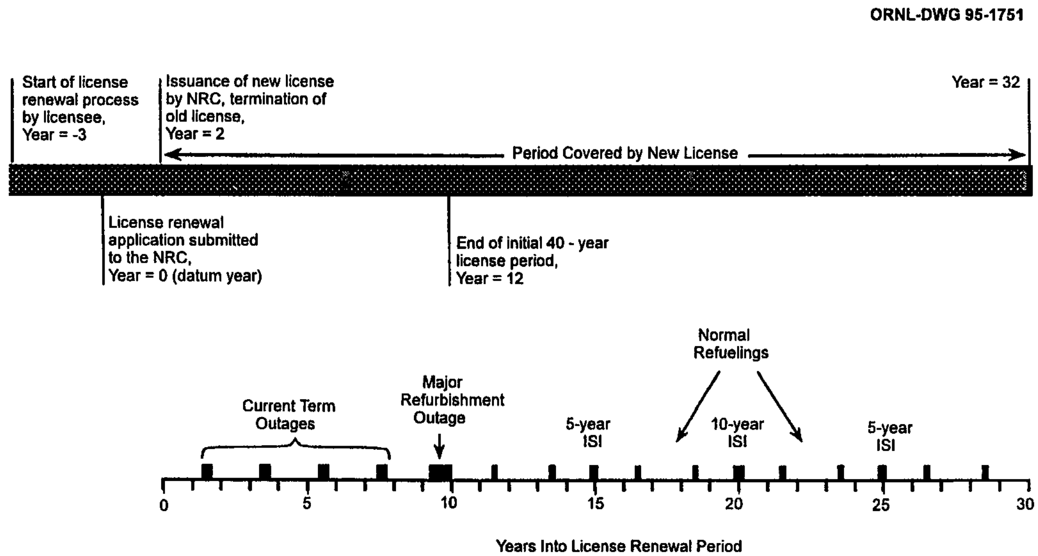

Figure 2.3 License renewal schedule and outage periods considered for environmental impact initiator definition.

license renewal are started shortly after the new license is granted, and that these are accomplished over several successive outages. They are completed by the time the plant completes its 40th year of operation, which is about 10 years into the new license term. The schedule for performing any major refurbishment activities will undoubtedly be highly plant specific, and such activities could well be spread throughout the term of the renewed license. Earlier timing of these activities provides the utilities with more time to recover the cost of the investment through the sale of energy produced. Thus, the schedules utilized for the present evaluations are reasonable, but alternative schedules are also possible.

The schedules utilized were similar for both the BWR and PWR programs. However, the typical programs have little need for an extended outage because the extent of major refurbishment activities is relatively modest. The "major refurbishment outage" duration for the typical programs was reduced compared with that deemed necessary for the conservative case scenarios.

2.6.2.9 Outage Types and Durations

Activities carried out in support of license renewal and extended plant life were assumed to be performed primarily during selected outages. Five types of outages were used: normal refuelings, 5-year ISI outages, 10-year ISI outages, current term refurbishment outages, and major refurbishment outages. Figure 2.3 illustrates when these outages are assumed to occur. The current term outages fall within the 40-year period initially covered by the plant's current license, but with license renewal they occur during the period covered by the new license.

Outage types and durations were established to allow estimation of the rates at which environmental impacts might be generated as a result of license renewal activities. For example, the number of workers required at a site for a given outage is dependent on the amount of work to be performed (labor hours), the time available to accomplish the work, and the number of labor hours expended per person-week or person-day. The number of workers so identified, in turn, allows estimation of potential socioeconomic and other impacts to affected communities.

Table 2.5 summarizes the different outage types and durations for both reactor types and for both the typical and conservative license renewal scenarios. Additional discussion of the basis used in selecting outage durations is provided in Appendix B.

2.6.3 Typical License Renewal Scenario

The characteristics of the typical license renewal program are discussed briefly in Section 2.6.3.1. Listings of the SSCs likely to be subject to incremental aging management activities are provided. Listings of the types of SMITTR actions and major refurbishment activities that may be performed as part of a typical license renewal program are reviewed and discussed in Appendix B. Section 2.6.3.2 summarizes the impact initiator quantities expected to be generated by such a program. Section 2.6.3.2 compares the impact initiator quantities for the typical program scenarios with the impactor initiator quantities currently produced from routine reactor operation.

2.6.3.1 Characterization of Typical License Renewal Programs

The characterization of license renewal programs required that three key types of information be developed: (1) identification of the SSCs likely to be subject to incremental aging management activities, (2) candidate lists of the activities to be performed on these systems and components to suitably manage aging effects that could have potential environmental consequences, and (3) identification of environmental attributes (impact initiators) associated with those activities. The typical programs are intended to be representative of the typical or "average" plant's activities in support of license renewal. However, the typical programs are still somewhat conservative; that is, some plants will not require all of the actions identified in the typical programs. The typical license renewal scenarios were based on the following.

- The Monticello and Yankee Rowe lead plant life extension (PLEX) programs were carefully reviewed. Activities included in either program were, with some exceptions, incorporated into the typical license renewal scenarios. The information obtained from the lead plants was also used to establish both the numbers of SSCs subject to a given activity and the schedule for performing such activities.
- All activities included in the Part 54 Regulatory Analysis which were pertinent to passive, long-lived SSCs and which were not likely to be implemented because of other rules or regulations were retained as incremental actions. The Part 54 activities were retained both to maintain consistency with the updated Part 54

Regulatory Analysis and to allow for a modest amount of conservatism in the typical scenarios.

- As noted previously, recently enacted rules and regulations, in particular the Maintenance Rule, were taken into account in developing typical license renewal or PLEX-related activities.
- Surveys were made to help establish the likelihood that certain major activities would be performed by typical licensees seeking license renewal. In particular, assessments were made relative to steam generator replacement and reactor vessel annealing for PWRs, and for recirculation piping replacement for BWRs. These assessments reviewed the fraction of the affected reactor population that has already performed these refurbishment/replacement activities and ascertained whether such activities might need to be repeated for extended plant life. Based on the results of these reviews, it was assumed that typical license renewal programs will not need to include many such major activities.

Table 2.5 Outage duration summary

	Outage duration (months)	
Outage type	Conservative	Typical
Refueling	2	2
5-Year in-service inspection	3	3
10-Year in-service inspection	4	3
Current-term outage (refurbishment)	4	3
Major refurbishment outage	9	4

Typical program structures, systems, and components subject to incremental activities

Tables 2.6 and 2.7 list the SSCs used in the typical program evaluations for which incremental activities are assumed to be conducted during license renewal and extended life. Table 2.6 lists the items subject to incremental SMITTR actions; Table 2.7 lists items subject to major refurbishment/replacement activities. Table 2.6 includes SSCs subject to the addition of new or improved condition monitoring systems, as well as those subject to incremental SMITTR activities. Most of the items in these tables are common to both BWRs and PWRs.

Although the specific numbers of components and design features may be different for these two reactor types, they are similar enough that the environmental impacts resulting from aging management

Table 2.6 Typical program structures and components subject to incremental SMITTR[a] activities in support of license renewal

Item	BWR/PWR[b]
AC or DC busses	Both
Actuation and instrumentation channels	Both
Bellows	BWR
Building cranes and hoists	Both
BWR control rod drive mechanisms	BWR
BWR recirculation pumps and motors	BWR
Check valves	Both
Compressed air system	Both
Containment	Both
Emergency diesel generators	Both
Fan coolers	Both
Fuel pool	Both
Heat exchangers	Both
Heating, ventilation, and air conditioning	Both
Hydraulic or air operated valves	Both
Main condensor	Both
Main generator	Both
Main turbine	Both
Metal containment, including suppression chamber	BWR
Motor-operated valves	Both
Motor-driven pumps and motors	Both
Nuclear steam supply system supports	Both
PWR critical concrete structure—containment	PWR
PWR reactor coolant pump	PWR
Reactor pressure vessel	Both
Reactor pressure vessel internals	Both
Turbine-driven pumps and turbines	Both

[a]SMITTR = surveillance, on-line monitoring, inspections, testing, trending, and recordkeeping.
[b]BWR = boiling-watert reactor; PWR = pressurized-water reactor.

Table 2.7 Typical program systems, structures, and components subject to major refurbishment or replacement activities

Item	BWR/PWR[a]
BWR safe ends and recirculation and feedwater piping inside containment	BWR
Compressed air system	Both
Containment	Both
Emergency diesel generators	Both
Main generator	Both
Major structures, including buildings and pipe enclosures	Both
Motor-operated valves	Both
Piping sections	Both
Reactor containment building	Both
Reactor pressure vessel	Both
Reactor pressure vessel internals	Both
Steam generators	PWR
Storage tanks	Both

[a]BWR = boiling-water reactor; PWR = pressurized-water reactor

activities on these items will be reasonably similar for both reactor types. Differences in the numbers of like items employed in each plant design were taken into account in assessing impacts.

Certain SSCs such as the reactor recirculation piping for BWRs and steam generators for PWRs are unique to the plant design type. Potential impacts from aging management activities on such items were treated separately for the two major plant categories.

Definition of aging management activities

The incremental aging management activities carried out to allow operation of a nuclear power plant beyond the original 40-year license term will be from one of two broad categories: (1) SMITTR actions, most of which are repeated at regular intervals, and (2) major refurbishment or replacement actions, which usually occur fairly infrequently and possibly only once in the life of the plant for any given item.

Most of the SMITTR activities included in the present assessment were taken from the Safety-Centered Aging Management program defined previously and utilized for the 10 CFR Part 54 License Renewal Regulatory Analysis (NUREG-1362). However, the current effort includes additional items and activities, because the previous analysis focused only on SSCs important to safety, whereas for the current efforts it has been assumed that licensees will also perform actions aimed at ensuring reliable and efficient electrical power production. Thus, many balance-of-plant SSCs are included here which were not included in the 10 CFR Part 54 evaluations.

In certain cases a SMITTR activity could involve replacement or refurbishment of the SSC being addressed. Any such SMITTR replacement/refurbishment activities for a particular item typically occur more than once in the extended life of the plant.

Table B.1 of Appendix B lists the incremental SMITTR actions used as the basis for estimating license renewal environmental impacts. It indicates the specific aging detection and mitigation actions performed on each SSC of concern. These activities include some which are undertaken only to improve reliability or economic performance; thus, Table B.1 includes several active components in addition to the passive, long-lived SSCs that are the focus of 10 CFR Part 54.

Table B.2 of Appendix B lists the major refurbishment or replacement activities used to estimate environmental impacts. The table indicates the fractions or portions of the SSCs involved which are subject to the stated actions. Unless otherwise noted, 100 percent of an SSC was assumed to be replaced or refurbished. As with the list of actions cited in Table B.1, the quantities assumed were based in part on the information provided in the industry pilot and lead plant studies and from reported existing industry experience on major refurbishments (Sciacca 1/3/93 and 1/13/93). In other cases engineering judgment provided the basis for the portions of the systems or structures being replaced or refurbished. The extent of major refurbishments envisioned for typical license renewal programs is fairly modest.

2.6.3.2 Typical Program Incremental Initiator Quantities

Table 2.8 summarizes the typical program impact initiator quantities resulting from the incremental SMITTR and major refurbishment/replacement activities assumed to be carried out in support of license renewal and extended plant life. Estimates of the amounts generated are shown for each of the outage types previously discussed, during which these impact initiators are expected to be generated from license renewal activities. Separate estimates are provided for BWRs and PWRs. All figures are shown on a per-plant basis (i.e., for a single nuclear plant).

A comparison of the figures shown in Table 2.8 with current reactor experience as discussed in Section 2.5.2 indicates that, for the typical license renewal scenario, incremental license renewal effects are expected to be relatively modest. For example, with current nuclear plant operation, roughly 1.5 million person-hours are expended each year for on-site operations and maintenance activities. The incremental efforts associated with license renewal-related activities are estimated to add between 500,000 and 700,000 person-hours for all such activities over the remaining

Table 2.8 Typical license renewal program environmental impact initiators

Outage type	Labor hours	Additional on-site personnel	Waste volumes (as-shipped) (m^3)	Occupational rad exps (person-sieverts)	Waste disposal costs (1994$)[a]	Labor costs (1994$)[a]	Capital costs (1994$)[a]	Total on-site costs (1994$)[a]	Off-site costs (1994$)[a]	Total costs (1994$)[a]
Boiling-water reactors										
Full power operation (20 yrs)	0	0	0	0.00	0	0	0	0	0	0
Normal refueling[b]	4,148	10	2	0.04	23,000	196,940	215,460	435,400	47,751	483,151
5-yr ISI[c] refueling[d]	38,675	63	17	0.71	244,000	1,789,900	314,100	2,348,000	0	2,348,000
10-yr ISI refueling[e]	62,208	110	30	0.91	424,000	3,082,450	589,550	4,096,000	0	4,096,000
Current term refurbishments[f]	45,294	71	17	0.10	245,000	1,715,040	579,360	2,539,400	177,347	2,716,747
Major refurbishment outage[g]	298,375	361	69	1.53	976,000	12,585,040	57,589,360	71,150,400	13,804,688	84,955,088
Total all occurrences	660,000	—	220	4.57	3,052,000	27,700,000	62,800,000	93,600,000	14,900,000	108,500,000
Pressurized-water reactors										
Full power operation (20 yrs)	0	0	0	0.00	0	0	0	0	0	0
Normal refueling[b]	3,488	8	1	0.03	18,000	166,265	145,635	329,900	27,179	357,079
5-yr ISI refueling[d]	20,935	33	11	0.30	153,000	953,750	185,250	1,292,000	13,886	1,305,886
10-yr ISI refueling[e]	37,482	60	22	0.51	313,000	1,691,600	309,400	2,314,000	831	2,314,831
Current term refurbishments[f]	45,924	72	18	0.11	272,000	1,741,880	580,920	2,594,800	176,530	2,771,330
Major refurbishment outage[g]	219,018	264	44	0.79	1,631,000	9,108,830	49,380,970	60,120,800	12,068,028	72,188,828
Total all occurrences	510,000	—	170	2.61	3,482,000	21,000,000	53,500,000	78,000,000	13,000,000	91,000,000

Notes:

[a]All cost figures are undiscounted 1994 dollars
[b]8 occurrences, 2-month duration each
[c]ISI = in-service inspection
[d]2 occurrences, 3-month duration each
[e]1 occurrence, 4-month duration
[f]4 occurrences, 4-month duration each
[g]1 occurrence, 9-month duration

To convert m^3 to ft^3, multiply by 35.32.
To convert person-sievert to person-rem, multiply by 100.

Source: Science and Engineering Associates, Inc., January 1995.

life of a typical plant. Thus, the license renewal activities would add roughly 20,000 person-hours per year, which is a small increment compared to the 1.5 million person-hours per year typical of current reactor operation.

Table 2.8 indicates that the number of additional on-site personnel needed to accomplish license renewal-related activities is quite modest for most periods when such activities will be performed. The exception is the major refurbishment outage, when an average of between 200 and 400 additional personnel may be needed. Note that these personnel are in addition to the 700- to 800-person temporary work force typically called in to assist with current outages at nuclear power plants (see Table 2.4). The estimates of additional personnel presented in Table 2.8 are based on the assumption that the incremental work efforts are spread uniformly over the entire duration of the associated outages. In reality, some peaking of staffing requirements will occur during each outage. Additional analyses were performed to evaluate the extent of such peaking, and these analyses are discussed in Appendix B. For the typical BWR license renewal scenario, these analyses indicated that the on-site temporary work force would peak at about 1000 personnel. This peak occurs during the major refurbishment outage, and it includes the temporary work force needed to accomplish refueling and routine outage activities (e.g. routine maintenance and ISI activities) as well as license renewal-related activities. For the PWR, the corresponding temporary worker requirements reach a peak at about 900 additional staff. This peak requirement occurs during the current term outages.

The incremental occupational radiation exposure estimated to accrue because of license renewal activities is between 2.5 and 5 person-sievert (250 and 500 person-rem). On an annualized basis, this represents an increase in annual exposures of about 3 to 4 percent relative to current reactor operation experience.

LLW generation resulting from license renewal activities is projected to be between 185 and 220 m^3 (6,000 and 8,000 ft^3) of as-shipped LLW over the remaining life of the plants. Currently, PWRs typically generate about 250 m^3/year (8800 ft^3/year); the amount disposed of at BWRs has been about 560 m^3/year (19,700 ft^3/year). Thus, the amount of LLW expected to be added because of license renewal activities is roughly the equivalent of one-half to one year's production of waste under current operating conditions. This represents an increment over the remaining life of the plants of about 1 to 3 percent relative to what would be produced with continued present-basis plant operation.

Table 2.8 presents several types of costs associated with license renewal and extended plant life. These include incremental costs associated with additional labor, waste disposal, capital costs, and off-site costs (off-site engineering and administrative support). For the typical BWR license renewal program, the total incremental costs are estimated to be almost \$110 million; those for the typical PWR program are estimated to be about \$90 million. Although these costs will be incurred over the remaining life of a plant, more than half of these costs might well be incurred in the first few years after a renewed license is granted. For comparison purposes, recent non-fuel operations and maintenance (O&M) costs at U.S. nuclear plants have averaged about \$75 million per year for a 1000-MW(e) plant, and capital additions have averaged about \$28 million per year (1994 dollars). Thus, the estimated labor and capital expenditures associated with incremental license renewal activities over the remaining life of a plant with a renewed license are the equivalent of roughly a year's expenditures for O&M and capital additions currently experienced by LWRs, or less than a 5 percent increase for such expenditures on an annualized basis.

2.6.4 Conservative License Renewal Scenario

The characteristics of the conservative case license renewal programs are discussed briefly in Section 2.6.4.1. As was done in Section 2.6.3.1 for the typical programs, listings are provided of the SSCs likely to be subject to incremental aging management activities. Listings of the types of SMITTR actions and major refurbishment activities that may be performed as part of a conservative license renewal program are reviewed and discussed in Appendix B. Section 2.6.4.2 summarizes the impact initiator quantities expected to be generated by such programs and compares the impact initiator quantities for the conservative program scenarios with the impactor initiator quantities currently produced in routine reactor operation.

2.6.4.1 Characterization of the Conservative Program

The conservative license renewal scenarios are intended to capture what might occur for those outlier plants whose impacts will be considerably greater than what is typical of the reactor population as a whole. Because these conservative, or bounding, programs are quite comprehensive, they subsume impacts from more atypical plants.

The conservative case license renewal scenario uses a conservative basis for projecting activities and impacts. The primary bases and assumptions are as follows.

- In contrast with the typical programs, the recently enacted rules and regulations, in particular the Maintenance Rule, were not taken into account in revising license renewal or PLEX-related activities. This simplified approach was taken because accounting for such effects would have a negligible impact on the estimates of environmental impact initiator quantities.
- All activities included in the Part 54 Regulatory Analysis were retained as incremental actions. In many instances, the number of SSCs subjected to particular SMITTR activities was increased to reflect optional actions on the part of licensees to better ensure reliable and economical service for balance-of-plant systems and components.
- The major refurbishment and replacement activities included in the programs are quite expansive and encompass all aspects of the plant designs (e.g., structural, mechanical, and electrical). Similarly, the extent of such activities for particular SSCs is considerable in most cases and is more extensive than that anticipated for the average plant seeking license renewal.
- As was previously noted, several of the major refurbishment activities included in the present estimates have already occurred at many nuclear plants. These are activities such as steam generator replacement in PWRs and recirculation piping replacement in BWRs. These activities are included in the conservative case scenarios to encompass those plants that must perform such activities to achieve the desired extended plant life and efficiency, but that have not already done so or that might have to repeat such actions.

License renewal program definition

Conservative program SSCs subject to incremental activities. The conservative program SSCs assumed to be subject to incremental SMITTR activities included all of the SSCs identified in Table 2.6 for the typical program. In addition, the conservative program included the items listed in Table 2.9. The conservative program, in most instances, also included a greater number of a given type of SSC subject to SMITTR actions than did the typical programs. For example, the conservative programs included roughly twice the number of motor-operated valves subject to incremental aging detection and mitigation actions as did the typical programs. This approach was taken with the conservative programs to encompass what might occur at outlier plants.

Both the SSCs subject to incremental SMITTR activities and those subject to major refurbishment activities for the conservative program are more inclusive than those included in the typical program scenarios. A comparison of Tables 2.6 and 2.7 with Tables 2.9 and 2.10 readily demonstrates the more comprehensive nature of the conservative program compared with the typical program scenarios.

Table 2.9 Conservative program additional structures and components subject to incremental SMITTR[a] activities in support of license renewal

Item	BWR/PWR[b]
BWR control rod drive mechanism	BWR
Compressed air system	Both
Emergency diesel generator	Both
Fan cooler	Both
Main turbine	Both

[a]SMITTR = surveillance, on-line monitoring, inspections, testing, trending, and recordkeeping.
[b]BWR = boiling-water reactor; PWR = pressurized-water reactor.

Table 2.10 lists items subject to major refurbishment/replacement activities. Most of the items in these tables are common to both BWRs and PWRs.

Definition of conservative program aging management activities. As for the typical programs, the incremental aging management activities carried out for the conservative license renewal scenarios to allow operation beyond the original 40-year license term will include both SMITTR activities and major refurbishment activities.

The SMITTR activities associated with the conservative programs are quite similar to those developed for the typical programs, except that they cover additional types and numbers of SSCs. The scenarios developed

Table 2.10 Conservative program systems, structures, and components subject to major refurbishment or replacement activities

Item	BWR/PWR[a]
Building crane	Both
BWR recirculation pump and motor	BWR
BWR safe ends and recirculation and feedwater piping	BWR
Concrete imbedments	Both
Condensate storage tank	Both
Control room communication systems	Both
Electrical cables in and out of containment	Both
Electrical raceways	Both
Emergency diesel generator	Both
Feedwater heater	Both
Heating, ventilation, and air conditioning	Both
Main generator	Both
Main turbine	Both
Major structures, including buildings and pipe enclosures	Both
Metal containment, including suppression chamber	BWR
Nuclear steam supply system supports	Both
Pressurizer and surge line	PWR
Piping section	Both
PWR coolant and feedwater piping inside containment	PWR
Radioactive waste processing system	Both
Reactor containment building	Both
Reactor pressure vessel	Both
Reactor pressure vessel internals	Both
Steam generator	PWR
Steam valve	Both
Switchyard	Both
Turbine pedestal	Both
Ultimate heat sink structures	Both

[a]BWR = boiling-water reactor; PWR = pressurized-water reactor.

for the conservative programs assumed that many balance-of-plant SSCs would be subject to license renewal-related activities to better ensure reliable and economical operation for the extended life of the plant.

Table B.1 of Appendix B lists the incremental SMITTR actions used as the basis for estimating license renewal environmental impacts. It indicates the specific aging detection and mitigation actions performed on each SSC of concern.

Table B.1 indicates the specific SMITTR activities included in each type of program, but it does not indicate the number of SSCs subject to a particular activity. The programs defined for the conservative case scenarios in all instances match or exceed the number of SSCs included in the corresponding typical license renewal programs.

The list of major replacement and refurbishment activities included here was derived largely from areas of concern identified in the industry pilot and lead NP-5181M, EPRI NP-5289P, EPRI NP-5002). This is true for both the conservative and typical scenarios. Those studies did not necessarily indicate that all of the items addressed should be replaced or undergo major overhauls. However, for all items addressed, there was sufficient concern over their long-term integrity that investigators thought, as a minimum, that additional analysis was warranted.

Although replacement may not have been indicated for the pilot and lead plants, at least a few plants may well face extensive actions of this type to ensure safe and economical operation throughout the renewal term. Therefore, regardless of the specific determinations for the pilot and lead plants, the SSCs of concern identified in those studies form a representative list of candidate items for inclusion in major replacement and refurbishment actions for outlier plants, and thus for the conservative scenarios. Other items included in this list were drawn from actions that have already occurred at one or several operating power plants. BWR recirculation piping replacement and PWR steam generator replacement fall into this category. Although many plants will undertake the replacement of such items during the current license term, there may be other plants which would undertake such tasks only to allow for extended plant operation. Inclusion of these activities in the conservative scenario evaluations provides for an upper bound estimate of what at least a few plants may undertake for license renewal.

Table B.2 of Appendix B lists the major refurbishment or replacement activities used to estimate environmental impacts for the conservative case scenarios. Unless otherwise noted, 100 percent of an SSC was assumed to be replaced or refurbished.

2.6.4.2 Conservative Program Incremental Initiator Quantities

Table 2.11 summarizes the conservative program impact initiator quantities resulting from the incremental SMITTR and major refurbishment/replacement activities assumed to be carried out in support of license renewal and extended plant life. A comparison with the estimates provided for the typical programs (Table 2.8) indicates that the conservative program scenario estimates of impact initiator quantities are factors of four to six greater than those for the typical programs. The type of information provided in Table 2.11 is identical to that provided in Table 2.8. Separate estimates are provided for BWRs and PWRs, and all figures are shown on a per-plant basis.

Table 2.11 Conservative license renewal program environmental impact initiators

Outage type	Labor hours	Additional on-site personnel	Waste volumes (as-shipped) (m^3)	Occupational rad exps (person-sieverts)	Waste disposal costs (1994\$)[a]	Labor costs (1994\$)[a]	Capital costs (1994\$)[a]	Total on-site costs (1994\$)[a]	Off-site costs (1994\$)[a]	Total costs (1994\$)[a]
Boiling-water reactors										
Full power operation (20 yrs)	49,900	1	0	0.00	0	2,089,856	0	2,089,856	0	2,089,856
Normal refueling[b]	11,352	27	5	0.10	64,182	556,407	612,043	1,232,632	131,856	1,364,488
5-yr ISI[c] refueling[d]	48,406	78	21	0.27	290,508	2,258,137	712,251	3,260,896	0	3,260,896
10-yr ISI refueling[e]	101,308	122	38	1.08	537,102	4,585,522	1,250,536	6,373,160	0	6,373,160
Current term refurbishments[f]	732,280	866	233	1.91	3,303,684	28,170,043	10,843,605	42,317,332	3,122,803	45,440,135
Major refurbishment outage[g]	1,642,760	867	814	15.61	11,525,736	73,719,268	119,968,099	205,213,104	28,546,104	233,759,207
Total all occurrences	4,910,000	—	1,900	26.66	26,372,000	202,000,000	170,900,000	399,300,000	42,100,000	441,400,000
Pressurized-water reactors										
Full power operation (20 yrs)	49,900	1	0	0.00	0	2,089,856	0	2,089,856	0	2,089,856
Normal refueling[b]	8,733	21	3	0.07	46,166	406,936	410,540	863,642	79,897	943,539
5-yr ISI refueling[d]	28,550	46	13	0.35	185,790	1294,224	451,076	1,931,090	50,734	1,981,824
10-yr ISI refueling[e]	62,295	75	29	0.66	416,620	2,867,021	845,401	4,129,042	74,282	4,203,324
Current term refurbishments[f]	768,460	909	264	2.00	2,889,204	29,607,382	9,687,766	43,184,352	2,821,826	46,006,178
Major refurbishment outage[g]	3,241,260	1,713	1,324	13.80	20,204,944	139,806,842	110,947,895	270,959,681	26,185,773	297,145,454
Total all occurrences	6,550,000	—	2,500	23.74	36,919,300	269,000,000	154,700,000	460,700,000	38,300,000	499,000,000

Notes:

[a]All cost figures are undiscounted 1994 dollars
[b]8 occurrences, 2-month duration each
[c]ISI = in-service inspection
[d]2 occurrences, 3-month duration each
[e]1 occurrence, 4-month duration
[f]4 occurrences, 4-month duration each
[g]1 occurrence, 9-month duration

To convert m^3 to ft^3, multiply by 35.32
To convert person-sievert to person-rem, multiply by 100

Source: Science and Engineering Associates, Inc., January 1995.

A comparison of the figures shown in Table 2.11 with current reactor experience as discussed in Section 2.5.2 indicates that, for the conservative license renewal scenario, incremental license renewal effects are expected to be fairly significant. The incremental efforts associated with license renewal-related activities are estimated to add between 5 million and 7 million person-hours for all such activities over the remaining life of a conservative plant. These increments for license renewal can be compared with the roughly 1.5 million person-hours expended annually with current reactor operation.

If the license renewal efforts were uniformly spread over the 30-year period that a renewed license would be in effect, they would increase annual labor requirements by 10 to 15 percent. The effect of the incremental license renewal labor will be even more significant for certain periods. For example, the number of additional workers needed to accomplish the major refurbishment activities during the major refurbishment outage could potentially double or triple the number needed during a normally scheduled outage. The projected number of additional workers needed for the BWR major refurbishment outage is almost 900, averaged over the entire outage. For certain periods during this outage, the number of additional workers is estimated to be about 1200. For the PWR, the outage average increment in additional personnel needed for the major refurbishment outage is about 1700, and the number is expected to peak at about 2300 for certain periods during this outage. Note that these estimates of peak incremental personnel include the 700- to 800-person temporary work force typically called in to assist with current outages at nuclear power plants (see Table 2.4).

Appendix B provides additional discussion of license renewal-related incremental staffing requirements.

The overall occupational radiation exposure estimated to accrue because of conservative program license renewal activities is between 23 and 24 person-sievert (2300 and 2400 person-rem). The large increase compared with the exposures anticipated for the typical programs is largely a result of the extensive major refurbishment activities expected to be undertaken with the conservative program scenarios. On an annualized basis, this is equivalent to an increase in annual exposures of about 20 to 30 percent relative to current reactor operation experience.

LLW generation from license renewal activities is projected to be between 1,900 and 2,500 m^3 (65,000 and 90,000 ft^3) of as-shipped LLW over the remaining life of the plants. Currently, PWRs typically generate about 250 m^3/year (8800 ft^3/year); the amount disposed of at BWRs has been about 560 m^3/year (19,700 ft^3/year). Thus, the amount of LLW expected to be added because of conservative program license renewal activities represents several years worth of production of waste under current operating conditions. This represents an increment over the remaining life of the plants of about 11 percent annually for the BWRs and about 30 percent annually for the PWRs relative to what would be produced with present-basis, continued plant operation. The larger percentage of PWR LLW results primarily from the large volume of the steam generators, which it is assumed will be replaced for the conservative program.

Table 2.11 indicates that the overall incremental costs associated with conservative program license renewal activities are projected to be in the range of $450 million to $500 million per plant (1994 dollars). With current nuclear plant operation, annual expenditures for fuel, O&M, and capital costs are in the range of $150 million to $250 million, depending on individual plant conditions. Thus, the license renewal expenditures represent 2 to 4 years of current overall operating costs.

2.6.5 Impact Initiator Estimate Uncertainties

The NRC staff believes that the license renewal scenarios presented in Section 2.6.4 reasonably characterize both the nature and magnitude of licensee activities that may be undertaken in support of license renewal and extended plant life. Both the typical and conservative programs include some discretionary activities that are assumed to be undertaken by licensees to better ensure economical and reliable plant operation, and that are in addition to those activities performed to meet the requirements of 10 CFR Part 54. The licensee actions in response to the 10 CFR Part 54 requirements, believed to be fairly modest, consist of a considerably smaller set of activities than those characterized for the typical license renewal scenarios. Appendix B presents estimates of impact initiator quantities strictly related to meeting the requirements of the license renewal rule. Thus, a broad spectrum of license renewal programs are possible, and the license renewal-related environmental impacts can vary widely from one plant to another, depending on specific plant conditions and on discretionary activities undertaken by each licensee/applicant. This variability in program characteristics, coupled with uncertainties in parameter values used to estimate specific initiator quantities, results in a considerable degree of uncertainty in the estimates presented in Tables 2.8 and 2.11. Although a rigorous uncertainty analysis has not been performed, the estimates of individual impact initiators provided in Table 2.8 for the typical programs are judged to have uncertainties in the range of ±30 percent. The more bounding assumptions employed for the conservative scenarios reduce the likelihood that the actual impact initiators experienced could be much higher than those presented in Table 2.11. The uncertainty range for the Table 2.11 estimates, therefore, is judged to be on the order of +10 percent to −30 percent.

2.7 SUMMARY

This chapter described operating U.S. nuclear power plants and described the nature of their interactions with the environment. The basic requirements of the license renewal rule, 10 CFR Part 54, were reviewed with the focus on aspects which may result in incremental environmental impacts. Chapter 2 also described both typical and conservative license renewal programs characterized for the purpose of estimating license renewal-related environmental impacts. Estimates were provided of environmental impact initiators associated with these programs. These impact initiators are used in the balance of this document to identify and quantify anticipated environmental impacts associated with nuclear power plant license renewal.

2.8 ENDNOTES

1. Construction of nuclear units Grand Gulf Unit 2, Perry Unit 2, and Washington Nuclear Project Units 1, 3, 4, and 5 has been suspended; therefore,

these units are not considered in this GEIS.

2. This category is generally discussed as a separate source of liquid waste primarily for PWRs in which the water has a different radionuclide content and chemistry from primary coolant.

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4. ENVIRONMENTAL IMPACTS OF OPERATION

4.1 INTRODUCTION

Nuclear power plant operations during the license renewal term will result in a continuation of most of the impacts that were occurring prior to license renewal. Some operational procedures will change, however, in response to efficiency, reliability, and safety goals. These new procedures may result in a new baseline of plant-induced impacts that will continue throughout the license renewal term. In addition, the environmental receptors such as air, water, population, and biotic communities may be changing. These receptor changes in turn will influence the significance of any plant-induced impacts. Therefore, this chapter defines the prelicense-renewal baseline for plant-induced impacts and additional impacts due to a changing environment, refurbishment, and changes in plant operation.

It is the intent of this chapter to discuss all substantive issues of concern that were identified in the scoping process (Section 1.3). This chapter is organized according to the major modes by which nuclear power plants affect the environment. Because the cooling system is a major mode of interaction with the environment and because the three types of cooling systems have substantially different effects, the first three sections address the impacts of operation for each of the three cooling system types. Transmission lines have distinctly different effects from cooling systems, so they are discussed separately in Section 4.5. Operation of nuclear power plants also has potential human health, socioeconomic, and groundwater effects that are not closely related to either the cooling system or the transmission lines. These effects are discussed in Sections 4.6, 4.7, and 4.8.

The issue of impacts to threatened or endangered species is potentially relevant to all cooling system types and to transmission lines. Review of power plant operations has shown that neither current cooling system operations nor electric power transmission lines associated with nuclear power plants are having significant adverse impacts on any threatened or endangered species. However, widespread conversion of natural habitats and other human activities continues to cause the decline of native plants and animals. As biologists review the status of species, additional species threatened with extinction are being identified; consequently, it is not possible to ensure that future power plant operations will not be found to adversely affect some currently unrecognized threatened or endangered species. In addition, future endangered species recovery efforts may require modifications of power plant operations. Similarly, operations-related land-disturbing activities (e.g., spent fuel and low-level waste storage facilities) could affect endangered species. As noted in Section 3.2, without site-specific and project-specific information, the magnitude or significance of impacts on threatened and endangered species cannot be assessed. For these reasons, the nature and significance of nuclear power plant operations on as yet unrecognized endangered species cannot be predicted; and no generic conclusion on the significance of potential impacts on endangered species can be reached. The impact on threatened and endangered species, therefore, is a Category 2 issue and will not be discussed further in this chapter.

4.2 ONCE-THROUGH COOLING SYSTEMS

A once-through cooling system can affect the environment by withdrawing a large amount of water, heating it, adding biocides, and discharging it back to the receiving body. The main issues associated with plants using such a system are (1) effects on aquatic organisms due to changes in water quality, entrainment, and impingement; (2) water-use conflicts; and (3) effects on groundwater quality, hydrology, and use. These issues as they relate to license renewal are addressed in this section.

The following sections discuss the potential effects of operation of once-through condenser cooling systems on surface water quality, hydrology, and use (Section 4.2.1) and aquatic ecology (Section 4.2.2). Section 4.2.2.2 summarizes the conclusions for each of these issues.

4.2.1 Surface Water Quality, Hydrology, and Use

This section considers how once-through cooling systems may alter surface water quality, hydrology, and quantity; the consequent biological effects of such changes and the methodology used to arrive at conclusions are described in Section 4.2.2. Each issue is described and, as appropriate, illustrated with examples from operating nuclear power plants. Any ongoing effects will probably continue into the license renewal term, assuming that the cooling system design and operation will not change for any plant under the requirements for license renewal. Judgments about the significance of these issues during the license renewal term are based on published information, agency consultation, and information provided by the utilities (Appendix F) on every nuclear power plant in the United States. The conclusions reached in Section 4.2.1 apply to all nuclear power plants with once-through cooling systems.

Seventy nuclear power plants have a once-through cooling system (see Table 2.2). The operation of once-through cooling systems alters water quality primarily through the discharge of heat and chemicals to a receiving body of water. The largest volumes of discharge are associated with the main condenser cooling system, but there are other sources of liquid effluents (e.g., the service water system and sanitary wastes). Because the volumes of water discharged from other systems are relatively small compared with those of the once-through condenser cooling system (typically around 10 percent), concern about water quality impacts of discharges has generally focused on the condenser cooling system. The amounts of heated effluent from such a system can be large; a nuclear power plant with once-through cooling discharges water at about 46 m^3/s (736,000 gal/min) per 1000 MW(e) with a temperature increase of 10°C (18°F).

4.2.1.1 Regulation of Condenser Cooling System Effluents

The U.S. Nuclear Regulatory Commission (NRC) considered the costs and benefits of alternative condenser cooling systems (including potential impacts on water quality and aquatic ecology) in the environmental statements associated with issuance of construction permits and operating licenses. Once a plant is operating, however, the continuing regulation of nonradiological impacts on water quality and aquatic ecology is primarily the responsibility of the U.S. Environmental Protection Agency (EPA) or the applicable state permitting agency. This section describes the environmental statutes that underlie the regulation of impacts on aquatic resources from operating nuclear power plants. An understanding of the requirements of these statutes and the procedures under which aquatic resources effects are controlled by the permitting agencies is important to the interpretation of the issue categories.

As with other industries, discharges from steam-electric power plants are regulated under the Clean Water Act (CWA). Because power plants discharge wastewater into surface bodies of water, they must obtain a National Pollutant Discharge Elimination System (NPDES) permit under Section 402 of the CWA (33 USC 1342). The NPDES permit specifies the discharge standards and monitoring requirements that the facility must achieve for each point of discharge or outfall. NPDES permits must be renewed every 5 years, and during the renewal process, the plant must certify that no changes have been made to the facility that would alter aquatic impacts and no significant adverse impacts on aquatic resources have been observed. An NPDES permit is issued by EPA or, more commonly, a designated state water quality agency.

Under Section 316(a) of the CWA [33 U.S.C. 1326(a)], state-established thermal effluent limitations in the NPDES permit may be modified to a less stringent level if it can be shown that the less stringent level (i.e., higher temperatures) is sufficient to "ensure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife" (Bugbee 1978). The regulatory agency's decision to allow alternative thermal discharge limitations is based on the utility's 316(a) demonstration, which may present considerable information about the actual or projected thermal impacts of the power plant discharge. Like the NPDES permit, the 316(a) "variance" must be renewed every 5 years, and the applicant must provide evidence to the permitting agency as to why the variance is still appropriate. A 316(a) determination is not necessary for those power plants that are able to meet state water temperature standards; this is the case for many nuclear power plants that use closed-cycle cooling systems (Appendix F). However, a biological assessment/study, similar to that which would be required by 316(a), may be required to ensure that the mixing zone meets water quality standards [Charles H. Kaplan, letter to G. F. Cada, Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee November 19, 1990].

Section 316(b) of the CWA [33 USC 1326(b)] requires that "the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact." Like NPDES permits and 316(a) determinations, 316(b) determinations are made by EPA or a state permitting agency based on data supplied in the applicant's 316(b) demonstration. The 316(b) determination need not be separated from the NPDES process. Although 316(b) determinations are usually one-time judgments that are not periodically reconsidered, a determination under CWA Section 316(b) is not permanently binding. Where circumstances have changed (e.g., fish population has changed, the initial determination was deemed inappropriate, or some adjustment in the operation of the intake structure is warranted), a full 316(b) demonstration could again be required by EPA during the license period.

The 316(a) and (b) demonstrations provide EPA (or a designated state permitting agency) a means for considering condenser cooling system effects on aquatic biota, not just on water quality per se. Other federal and state agencies with responsibilities for aquatic resources [e.g., the U.S. Fish and Wildlife Service (FWS), the National Marine Fisheries Service (NMFS), state fish and wildlife agencies] do not issue permits but are consulted in the development of NPDES permits and Section 316 determinations.

Under Section 401 of the CWA (33 USC 1341), an applicant for a federal license or permit (the utility in this case) must obtain a state water quality certification (i.e., the state must certify that the applicant's discharges will comply with state water quality standards). This requirement would apply, for example, to U.S. Army Corps of Engineers Section 404 permits for the disposal of dredged and fill material and to EPA-issued NPDES permits. Of course, issuance of an NPDES permit by a state water quality agency implies certification under Section 401.

Any pesticide must be registered under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (7 USC 136 et seq.); this includes the various chlorine compounds, bromine compounds, and molluscicides used to control biofouling in power plants. Registration requires development of toxicity data. Under FIFRA, no one can use a biocide except in accordance with labeled instructions. Information about toxicity developed by the biocide manufacturer as a FIFRA requirement may be used to determine permissible power plant discharge concentrations for the NPDES permit.

Other potential aquatic resource issues are the subjects of particular legislation or executive orders (EOs) with specific requirements that cannot be limited or eliminated. For example, potential effects of plant modifications on floodplains and wetlands must be considered under EOs 11988 and 11990, respectively. Modifications that entail disposal of dredged material may require a permit from the U.S. Army Corps of Engineers under Section 404 of CWA (Pub. L. 92-500). Because the impacts could range from small to large depending on the details of the site and the proposed construction, the potential effect on floodplains or wetlands is a Category 2 issue.

4.2.1.2 Water Quality/Hydrology

The continued operation of once-through condenser cooling systems will allow continuation of associated hydrologic changes, including altered current patterns at intake and discharge structures, altered salinity gradients, and altered thermal stratification of lakes. Water quality effects considered in this section include temperature effects on sediment transport capacity, scouring, eutrophication, and the discharge of biocides, sanitary wastes, and heavy metals.

4.2.1.2.1 Current Patterns

Operation of the cooling system usually causes changes in water currents in the immediate vicinity of both the intake and the outfall. The extent of the changes depends on the design and siting of the intake and discharge and the nature of the body of water (Langford 1983). Because many nuclear plants are located on large rivers, lakes, reservoirs or on the seacoast, such localized altered current patterns are minor. However, plants sited near small bodies of water may have marked effects on current patterns. Operation of the cooling water system of Oyster Creek Nuclear Generating Station (NGS) changed the flows of the lower portions of Oyster Creek and South Branch Forked River from alternating flows typical of estuarine streams to unidirectional flows with constant salinity. The South Branch Forked River became an intake canal, with salt water continuously moving upstream toward the power plant. Oyster Creek, on the other hand, became a discharge canal, with heated salt water moving continuously away from the plant. Although substantial changes to the hydrology and water quality of these small streams have been documented, there have been only minor effects on nearby Barnegat Bay (Kennish et al. 1984). Changes to current patterns are of small significance if they are localized near the intake and discharge of the power plant and do not alter water use or hydrology in the wider area. Because once-through power plants are located near substantial bodies of water that are not subject to extreme changes in volume or flow rate, cooling water withdrawals and discharges do not have major effects on the hydrology of these large bodies of water. Impacts during the license renewal period are expected to be of small significance for all plants. Localized effects on current patterns would have been manifested during the initial stages of plant operation and would have been mitigated if necessary at that time. Based on a review of the published literature and operational monitoring reports, operation of the cooling system is expected to cause only small, localized changes to current patterns near the power plant and would not contribute to the cumulative impacts. Further, consultation with the utilities and regulatory agencies during preparation of the draft GEIS, as well as their comments on the draft GEIS, revealed no concerns about the individual or cumulative impacts of cooling system operations on current patterns. The impacts of altered current patterns will continue to be localized and of small significance. No change in operation of the cooling system is expected during the license renewal term, so no change in effects on current patterns is anticipated. The effects on current patterns could be reduced by changing to a closed-cycle cooling system or by reducing the plants' generation rate. However, these measures would be costly and are not reasonable in light of the small benefits that might be gained from their implementation. Hence, no additional mitigation measures to reduce the impact of cooling system operations on current patterns are necessary in the renewal period. For these reasons, the effect of once-through cooling system operation on current patterns is a Category 1 issue.

4.2.1.2.2 Salinity Gradients

Power plants operating near estuaries can also alter salinity gradients. As noted, the Oyster Creek NGS cooling system converted two brackish creeks to canals with unidirectional flows and increased salinity to an average of 17 parts per thousand, similar to Barnegat Bay (Tatham et al. 1978). The two creeks have become hydrologic extensions of the bay because of operation of the power plant, causing significant changes in the original water quality and aquatic communities in the creeks because water quality is now essentially the same as that of the bay

(Chizmadia et al. 1984). Effects do not appear to extend beyond these creeks, which are also affected by dredging and thermal and chemical discharges.

Chesapeake Bay has a large number of power plants (mostly fossil-fueled) within the mesohaline (estuarine) zone. The fact that power plant discharges can alter salinity regimes, which in turn can change the type and abundance of aquatic organisms at the discharge site, is considered in the development of NPDES permits for Maryland power plants (MDNR 1988). Although natural salinity patterns have been altered by the discharge of Chalk Point (a large fossil-fueled power plant) into a shallow mesohaline area of Chesapeake Bay, other plants in the area, including the Calvert Cliffs Nuclear Power Plant, have not had consistent discharge effects on salinity (MDNR 1988). Any localized effects on biota near these Maryland power plants are attributed to thermal and habitat changes, rather than to salinity. Changes to salinity gradients are of small significance if they are localized near the intake and discharge of the power plant and are within the normal tidal or seasonal movements of salinity gradients that characterize estuaries. Based on a review of the published literature and operational monitoring reports, operation of the cooling system is expected to cause only small, localized changes to salinity gradients near the power plant. Further, consultation with the utilities and regulatory agencies during preparation of the draft GEIS, as well as their comments on the draft GEIS, revealed no concerns about the individual or cumulative impacts of cooling system operations on salinity gradients. These organizations did not identify a need for additional mitigation of impacts associated with this issue. For example, operation of numerous once-through power plants in the Chesapeake Bay estuary has not caused significant changes in salinity gradients. The effects on salinity gradients could be reduced by changing to a closed-cycle cooling system or by reducing the plants' generation rate. However, these measures would be costly and are not reasonable in light of the small benefits that might be gained from their implementation. Hence, no additional mitigation measures to reduce the impact of cooling system operations on salinity gradients are necessary in the renewal period. For these reasons, the effects of once-through cooling system operation on salinity gradients are a Category 1 issue.

4.2.1.2.3 Thermal Effects

Discharges of heated effluents have the potential to affect water quality in five ways: (1) water temperature increases, including altered thermal stratification of lakes, (2) temperature effects on sediment transport capacity, (3) scouring, (4) lowered dissolved oxygen concentrations, and (5) eutrophication. Heated water discharges tend to remain at (or move toward) the surface of lakes and rivers. These discharges form a plume of warm water that dissipates with distance from the source by rejecting heat to the atmosphere or mixing with cooler ambient waters. Mixing tends to occur more rapidly in rivers than in lakes because of increased turbulence. Also because of turbulence, rivers do not naturally thermally stratify; as a result, alteration of temperature stratification in rivers by nuclear power plants is not an issue. Impacts of thermal discharges to water quality are of small significance if discharges are within thermal effluent limitations designed to ensure protection of water quality and if ongoing discharges have not resulted in adverse effects on the five attributes of water quality identified above.

Temperature-induced density stratification of lakes and reservoirs is a principal regulator of water quality and organism distribution in deep waters. Thermal stratification can be changed in two general ways by once-through cooling of power plants: by the discharge of heated water and by the altered circulation patterns generated by pumping cooling water into and out of the power station (Coutant 1981). Temperature elevation can intensify stratification (through surface discharge of heated water), whereas enhanced circulation may break down stratification. The relative importance of these two counteracting processes depends on the characteristics of the site and cooling system.

Destratification can increase dissolved oxygen concentrations in deeper waters and decrease the solubility of phosphorus (which contributes to eutrophication), and may be a net benefit to warm-water fisheries by expanding available habitat. For example, Larimore and McNurney compared two nearby lakes in Illinois—Lake Shelbyville, an unheated flood control reservoir, and Lake Sangchris, a cooling lake for a coal-fired power plant. In contrast with the unheated lake, Lake Sangchris did not stratify in the summer. Furthermore, largemouth bass had a longer growing season and greater annual growth in the cooling lake.

On the other hand, Coutant (1981) noted that the common practice of using cool hypolimnetic water from deep intakes for power station cooling, with surface discharge, may increase the size of the warm epilimnion and decrease the amount of habitat available to cool-water fish. For example, thermal discharges from the Oconee Nuclear Station have increased the annual heat load of Keowee Reservoir by one-third and lowered the thermocline (boundary between warm surface waters and cool bottom waters) from between 5 and 15 m to as low as 27 m (Oliver and Hudson 1987), although neither specified thermal limits nor lethal temperatures were exceeded [Oliver and Hudson 1987; Duke Power Company response to NUMARC survey (NUMARC 1990)].

The McGuire Nuclear Station withdraws cool hypolimnetic water from Lake Norman and discharges the heated water at the surface. As with Oconee, this has the effect of increasing the size of the upper layer of warm water and decreasing the habitat available for cool-water fishes (e.g., striped bass) in the hypolimnion of Lake Norman. Temperature modeling indicated that increasing the maximum upper discharge temperature from 95 to 99°F during July, August, and September would conserve cool-water fish habitat in the lake by allowing smaller withdrawal rates of hypolimnetic waters and would lower the average heat content of the lake by allowing more heat to be dissipated to the atmosphere from the warmer localized area (Duke Power Company 1988; Lewis 1990). The increased thermal limit is not expected to substantially affect water quality or aquatic biota in the mixing zone. Following consultation with the North Carolina Department of Health and Natural Resources, the NPDES permit has been modified to allow the higher temperatures [Duke Power Company response to NUMARC survey (NUMARC 1990)]. Modeling reservoir heat budgets allows effects of thermal discharges on stratification to be predicted and used by utilities and regulatory agencies to develop the best heat dissipation scheme. Altered thermal stratification has never been a problem at most plants. At other plants (i.e., McGuire and Oconee), the issue has been periodically re-examined during the initial license period and mitigated as needed by adjusting thermal discharges.

The effects of altered thermal stratification on water quality and distribution of aquatic organisms are monitored during plant operation and are mitigated if necessary through the NPDES permit renewal process. Based on a review of the published literature and operational monitoring reports, operation of the cooling system has not altered thermal stratification at most power plants with once-through cooling systems. At the small number of plants where changes in thermal stratification have occurred, monitoring and modeling studies have been used to adjust the thermal discharges, thereby mitigating adverse impacts. As appropriate, these models take into account other thermal inputs to the receiving waterbody and therefore consider cumulative as well as individual plant effects. Consultation with the utilities and regulatory agencies during preparation of the draft GEIS, as well as their comments on the draft GEIS, revealed no concerns about the individual or cumulative impacts of cooling system operations on thermal stratification. The impacts of altered thermal stratification will continue to be of small significance. No change in operation of the cooling system is expected during the license renewal term, so no change in effects on thermal stratification is anticipated. The effects of thermal stratification could be reduced by changing to a closed-cycle cooling system or by reducing the plants' generation rate. However, these measures would be costly and are not reasonable in light of the small benefits that might be gained from their implementation. Hence, no additional mitigation measures to reduce the impact of cooling system operations on thermal stratification are necessary in the renewal period. For these reasons, the effects of once-through cooling system operation on thermal stratification are a Category 1 issue.

Increased temperature and the resulting decreased viscosity have been hypothesized to change the sediment transport capacity of water, leading to potential sedimentation problems, altered turbidity of rivers, and changes in riverbed configuration. Coutant (1981) discussed the theoretical basis for such possible changes, as well as relevant field investigations, and concluded that there is no indication that this is a significant problem at operating power stations. Examples of altered sediment characteristics are more likely the result of power plant structures (e.g., jetties or canals) or current patterns near intakes and discharges; such alterations are readily mitigated.

Based on review of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft GEIS, there is no evidence that temperature effects on sediment transport capacity have caused adverse environmental effects at any existing nuclear power plant. Regulatory agencies have expressed no concerns regarding the cumulative impacts of temperature effects on sediment transport capacity. Furthermore, because of the small area near the plant affected by increased water temperature, it is not expected that plant operations would have a significant contribution to cumulative impacts. Effects are considered to be of small significance for all plants. No change in the operation of the cooling system is expected during the license renewal term so no change in effects on sediment transport capacity is anticipated. Effects on sediment transport could be reduced by changing to a closed-cycle cooling system or by reducing the plants' generation rate. However, because the effects on sediment transport capacity are considered to be impacts of small significance and because these measures would be costly, the staff does not consider the implementation of these potential mitigation measures to be warranted. This is a Category 1 issue.

Cooling water discharges have the potential for scouring sediments, especially near high-velocity discharge structures, and for changing patterns of sediment deposition. Changes in sediment composition have been observed near operating power plants; for example, the Calvert Cliffs Nuclear Power Plant (MDNR), the Haddam Neck (Connecticut Yankee) Plant (Merriman and Thorpe), and the San Onofre Nuclear Generating Station (MRC). Fine-grained materials near the power plant discharge structure may become suspended by the discharge plume, resulting in localized increases in turbidity and a coarser-grained composition of sediments near the discharge. Depending on site-specific circumstances, changes in sediment composition near the power plant discharge may be regarded as adverse (shading of kelp beds; MRC), beneficial (enhancement of the productivity of benthic animals; MDNR), or inconsequential (Merriman and Thorpe). In all cases, sediment changes are localized.

Review of literature and operational monitoring reports, consultation with utilities and regulatory agencies, and comments on the draft GEIS confirm that sediment scouring has not been a problem at most power plants and has caused only minor localized effects at three plants. The impacts of sediment scouring will continue to be localized and of small significance. Contributions to cumulative impacts are not expected because of the small area near the power plant affected by higher velocity cooling water discharges, and no concerns about cumulative impacts were expressed by the regulatory agencies. The effects of sediment scouring could be reduced by changing to a closed-cycle cooling system or by reducing the plants' generation rate. However, these measures would be costly and are not reasonable in light of the small benefits that might be gained from their implementation. Hence, no additional mitigation measures to reduce sediment scouring effects are necessary in the renewal period. Sediment scouring due to discharge of condenser cooling water is a Category 1 issue.

An early concern about thermal discharges from power plants was that the heat would stimulate biological productivity and speed the process of eutrophication of natural waters. Coutant (1981) examined the evidence for such changes and concluded that, because enhanced mineralization of organic matter by bacteria would offset any thermally induced increases in organic production, significant eutrophication from direct thermal effects at most plants was unlikely. On the other hand, Coutant (1981) hypothesized that power plants that withdraw hypolimnetic water from stratified reservoirs and discharge heated effluents at the surface may (1) lengthen the growing season and (2) transfer previously unavailable nutrients from bottom waters to the surface. A longer growing season and more nutrients in the surface layer could result in more biological production and more organic matter that would settle into the hypolimnion and thus decay and consume oxygen; all of these are symptoms of eutrophication. This chain of events is most likely to be seen in small lakes that were oligotrophic (relatively unproductive) and supported hypolimnetic fisheries. Long-term monitoring of the McGuire Nuclear Station on such a reservoir indicates that operations have not resulted in increased eutrophication (NPDES No. NC0024392, 1988; NPDES No. NC0024392, 1990). Similarly, the operation of Oconee Nuclear Station does not appear to be causing eutrophication in Lake Keowee; long-term studies indicate that nutrient levels in the lake are low and appear to be declining [Duke Power Company, response to NUMARC survey (NUMARC 1990)]. Review of literature and operational monitoring reports, consultation with utilities and regulatory agencies, and review of comments on the draft GEIS indicate that power-plant-induced eutrophication has not been a problem at any existing nuclear power plant. Monitoring studies have not revealed cumulative impacts, and no concerns about nuclear power plants contributing to eutrophication in a cumulative way were expressed by the regulatory agencies. Effects are considered to be of small significance for all plants. No change in operation of the cooling system is expected during the license renewal term, so no change in the effects on eutrophification is anticipated. The eutrophication effects could be reduced by changing to a closed-cycle cooling system or by reducing the plants' generation rate. However, these measures would be costly and are not reasonable in light of the small benefits that might be gained from their implementation. Hence, no additional mitigation measures to reduce eutrophication effects are necessary in the renewal period. Accelerated eutrophication due to discharge of condenser cooling water is a Category 1 issue.

4.2.1.2.4 Chemical Effects

Some of the water quality issues that have been raised are potential chemical effects resulting from discharges of chlorine or other biocides, small-volume discharges of sanitary and other liquid wastes (Chapter 2), chemical spills, and heavy metals leached from cooling system piping and condenser tubing. Impacts of chemical discharges to water quality are considered to be of small significance if discharges are within effluent limitations designed to ensure protection of water quality and if ongoing discharges have not resulted in adverse effects on aquatic biota.

The discharged chemicals, including chlorine and other biocides, are regulated by the NPDES permit of each nuclear power plant. Regulatory concern about toxic effects of chlorine and its combination products, as well as operating experience with control of biofouling, has led many plants to eliminate the use of chlorine or reduce the amount used below those levels that were originally anticipated in the environmental statements associated with issuing the construction permit and operating license. Some power plants use mechanical cleaning methods or, because of the abrasive properties of particulates in the intake water, do not have to clean the condenser cooling system at all. Other plants chlorinate the condenser cooling or service water systems but can isolate certain portions for treatment (e.g., a single unit of a multi-unit plant), thereby allowing dilution to reduce the concentration of chlorine in the discharge. Because of these refinements and the process for modifying NPDES permit conditions as needed, water quality degradation from existing biocide usage at once-through nuclear power plants is not a concern among the regulatory and resource agencies consulted for this GEIS. Based on review of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft GEIS, water quality effects of discharge of chlorine and other biocides are considered to be of small significance for all plants. Small quantities of biocides are readily dissipated and/or chemically altered in the receiving waterbody so that significant cumulative impacts to water quality would not be expected. No change in operation of the cooling system is expected during the license renewal term, so no change in the effects of biocide discharges on receiving water quality is anticipated. Effects of biocide discharges could be reduced by increasing the degree of discharge water treatment, reducing the concentration of biocides, or by treating only a portion of the plants' cooling and service water systems at one time. However, because the effects of biocide discharges on water quality are considered to be impacts of small significance, the staff does not consider the implementation of these potential mitigation measures to be warranted. Discharge of chlorine and other biocides is a Category 1 issue. Discharges of sanitary wastes are regulated by NPDES permit, and discharges that do not violate the permit limits are of small significance.

Minor chemical spills or temporary off-specification discharges from sanitary waste treatment systems and other low-volume effluents (e.g., excessive coliform counts or total suspended solids levels, pH outside of permitted range) were cited as common NPDES permit violations in the utility responses to the NUMARC survey (NUMARC 1990). Such NPDES noncompliances have been variable, random in occurrence, and readily amenable to correction. These minor discharges or spills do not constitute widespread, consistent water quality impacts. Water quality effects of minor chemical discharges and spills are of small significance and do not have significant effects on aquatic biota for all plants and have been mitigated as needed. Significant cumulative impacts to water quality would not be expected because the small amounts of chemicals released by these minor discharges or spills are readily dissipated in the receiving waterbody. Spills and off-specification discharges occur seldom enough that regulatory agencies express no concern about them for operating nuclear power plants. While there may be additional management practices or discharge control devices that could further reduce the frequency of accidental spills and off-specification discharges, they are not warranted because impacts are already small and occur at low frequency and because such mitigation would be costly. The water quality impacts of permitted sanitary waste water and minor, nonradiological chemical discharges and spills are a Category 1 issue.

Heavy metals (e.g., copper, zinc, chromium) may be leached from condenser tubing and other heat exchangers and discharged by power plants as small-volume waste streams or corrosion products. Although all are found in small quantities in natural waters (and many are essential micronutrients), concentrations in the power plant discharge are controlled in the NPDES permit because excessive concentrations of heavy metals can be toxic to aquatic organisms. Discharge of metals and other toxic contaminants may also be subject to individual control strategies developed by the states to control toxic pollutants under the 1987 Amendments to the CWA. These strategies for point source discharges of toxic pollutants are implemented through the NPDES permit program. Langford reviewed the literature concerning heavy metal discharges from power plants and concluded that, during normal operations, concentrations generally are below the levels of detection. However, plant shutdowns for testing and refueling keep stagnant water in contact with condenser tubes and other metal structures for extended periods and could allow abnormally large amounts of metals to be leached. For example, Harrison et al. (DOE/ER-0317) detected elevated copper concentrations in the discharge during startup of Diablo Canyon Nuclear Power Station. Abalone deaths in the discharge area of the Diablo Canyon were attributed to high copper concentrations in the effluent following a shutdown period (Martin et al. 1977).

The ability of aquatic organisms to bioaccumulate heavy metals even at low concentrations has led to concerns about toxicity both to the biota and to humans that consume contaminated fish and shellfish. For example, bioconcentration of copper discharged from the Chalk Point Plant (a fossil-fuel power plant on Chesapeake Bay) resulted in oyster "greening" (Roosenburg 1969). Bioaccumulation of copper released from the H. B. Robinson Plant resulted in malformations and decreased reproductive capacity among bluegill in the cooling reservoir (ASTM STP 854); see Section 4.4.3. In all three of these examples of excessive accumulation of copper (Diablo Canyon, Chalk Point, and H. B. Robinson), replacement of the copper alloy condenser tubes with another material (e.g., titanium) eliminated the problem.

Concentrations of heavy metals in the discharges of once-through nuclear power plants are normally within NPDES permit limits and are quickly diluted or flushed from the area by the large volumes of the receiving water. Discharge of metals and other toxic contaminants may also be subject to individual control strategies developed by the states to control toxic pollutants under the 1987 Amendments to the CWA. These strategies for point source discharges of toxic pollutants are implemented through the NPDES permit program. Excessive discharges of metals have been corrected at the two nuclear power plants (Diablo Canyon and H. B. Robinson) that experienced problems during the original license period. Impacts of heavy metal discharges are considered to be of small significance if water quality criteria (e.g., NPDES permits) are not violated and if aquatic organisms in the vicinity of the plant are not bioaccumulating the metals. Based on review of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft GEIS, discharge of heavy metals leached from the condenser cooling system has been a problem at only Diablo Canyon and H. B.Robinson nuclear power plants, and mitigation was effective in both cases. Although cumulative impacts could result from the long-term accumulation and bioaccumulation of heavy metals, mitigation for individual plant effects has also reduced the potential for contributions to cumulative effects. Monitoring has not revealed a continuing problem with accumulation of heavy metals. No change in operation of the cooling system is expected during the license renewal term, so no change in metal concentrations in the cooling water discharge is anticipated. Effects of elevted metal concentrations could be reduced by replacing condenser tubes with alloys that are less likely to corrode. However, because the effects of metal concentrations on cooling water discharges are considered to be impacts of small significance and because the potential mitigation measures would be costly, the staff does not consider the implementation of these potential mitigation measures to be warranted. Elevated heavy metal concentrations in the condenser cooling water discharge is a Category 1 issue.

4.2.1.3 Water Use/Water Availability

Water use in the United States, as measured by freshwater withdrawals in 1985, averaged 15 million m^3/s (338 billion gal/day) (Carr et al. 1990). Four million m^3/s (ninety-two billion gal/day), or 27 percent of the water withdrawn, was consumed (e.g., by evaporation) and thus was not directly returned to the body of water. The remainder of the withdrawals (73 percent) was return flow available for reuse. In 1985, freshwater withdrawals by steam-electric power plants were approximately 5.7 million m^3/s (132 billion gal/day), which was 39 percent of the total freshwater withdrawals for all uses (Carr et al. 1990). About 2.4 million m^3/s (56 billion gal/day) of saline water was used for cooling by thermoelectric plants in coastal areas. Nuclear power plants accounted for 22 percent of the total thermoelectric withdrawals and fossil-fueled plants for 78 percent.

Consumptive uses remove the water from a stream or river and may or may not impact in-stream and off-stream beneficial uses. Return flows that are discharged to a stream are available to other users; freshwater withdrawals discharged to an estuary are effectively lost to further freshwater use (Carr et al. 1990). On the average, out of 0.4 m^3 (100 gal) withdrawn from surface waters for cooling of steam electric utilities, over 0.37 m^3 (98 gal) is returned almost immediately to the source body of water; less than 0.008 m^3 (2 gal) is consumed through evaporation (Solley et al. 1983). The consumptive loss for once-through cooling systems [0.5 m^3/s (18 ft^3/s) per 1000 MW(e)] is somewhat smaller than that attributed to cooling tower evaporation, which has been estimated to average 0.9 m^3/s (30 ft^3/second) per 1000 MW(e) (Giusti and Meyer 1978).

In those areas experiencing water availability problems, nuclear plant consumption may conflict with either existing or potential downstream municipal water use as well as with in-stream water uses. A shift in human population distribution and associated changes in demand for water could have important implications for the continued supply of cooling water for power generating facilities.

Impacts of power plant water use are considered to be of small significance since conflicts with other offstream or instream water users have not occurred and are not anticipated. The nuclear power plants that use once-through condenser cooling systems are located on large lakes, reservoirs, estuaries, oceans, and rivers, and—except possibly during extended periods of drought—are unlikely to experience problems with the water supply. Because net water consumption by facilities using once-through cooling is negligible compared with the size of the body of water, such plants should have only a limited potential for impacts on water availability for downstream use. Should water-use conflicts arise during operation of existing power plants, local officials who are responsible for allocating water resources would have to weigh the use of water for power generation. Based on review of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft GEIS, water use conflicts are found to be of small significance for all plants and cumulative impacts are not of concern. Net water consumption by facilities using once-through cooling is negligible compared with the size of the body of water. Because of abundant water supply, consumptive water use will have impacts of only small significance on riparian plant and animal communities at sites that use once-through cooling systems. No change in operation of the cooling system is expected during the license renewal term, so no change in effects on consumptive water use or riparian communities is anticipated. Effects on consumptive water use and riparian communities could be reduced by changing to a closed cycle cooling system or by reducing the plant's generation rate. However, because such changes would be costly, and because the effects on consumptive water use and riparian communities are of small significance, the staff does not consider the implementation of these potential mitigation measures to be warranted in light of the small benefit that might be gained. Both of these are Category 1 issues.

4.2.2 Aquatic Ecology

As noted in Section 4.2.1, large amounts of water are withdrawn by once-through cooling systems, passed through the condenser tubes, and discharged back to the body of water with an added load of heat and chemical contaminants. A total of 70 nuclear plants use once-through cooling (see Table 2.2). Initial concerns about effects of thermal effluents on aquatic biota (e.g., Krenkel and Parker 1969) were soon accompanied by concerns about impacts of biocide discharges and losses due to intake effects (i.e., impingement and entrainment). All of these issues have received considerable attention and study from utility and regulatory agency scientists in the past two decades, as exemplified by the numerous books and symposia devoted to resolving them (CONF-750425; Saila 1975; Schubel and Marcy 1978; Jensen 1978, 1981; Barnthouse and Van Winkle 1988). The aquatic resources issues that are considered in this section are entrainment (of fish, shellfish, phytoplankton, and zooplankton), impingement of fish and shellfish, thermal effects (heat shock, cold shock, thermal plume barrier to migratory fish, premature emergence of aquatic insects, enhanced susceptibility to parasitism and disease, stimulation of nuisance organisms, gas bubble disease, lower dissolved oxygen), and chemical effects (biocides and accumulation of contaminants in biota).

The following sections review the past and ongoing impacts on aquatic biota of operation of once-through condenser cooling systems. Any ongoing impacts will probably continue throughout the license renewal term because the cooling system design and operation is not expected to change for most plants. Judgments about the significance of these issues during the license renewal term are based on published information, agency consultation, and information provided by the utilities (Appendix F). These sources represent every nuclear power plant in the United States. In addition, seven case studies (Arkansas, McGuire, Cook, San Onofre, Crystal River, and combined effects of power plants on Lake Michigan and the Hudson River) were evaluated in greater detail. These case studies are examples of large once-through condenser cooling systems that affect a variety of aquatic environments (i.e., large lakes and reservoirs, oceans, and estuaries). Published information about these plants was reviewed to determine whether operation has resulted in demonstrable entrainment, impingement, or thermal impacts. For some of the case studies in Appendix F, cumulative effects of the operation of nuclear power plants in conjunction with other sources of stress to aquatic resources are considered.

4.2.2.1 Analysis of Issues

4.2.2.1.1 Entrainment of Phytoplankton and Zooplankton

As discussed in Section 2.3.5, water that is withdrawn for power plant cooling carries with it a variety of aquatic organisms. Those organisms that are small enough to pass through the debris screens in the intake pass through the entire cooling system and are exposed to heat, mechanical and pressure stresses, and possibly biocides before being discharged to the receiving water. This process, called entrainment, may affect phytoplankton, zooplankton, planktonic larval stages of benthic organisms such as shellfish (i.e., meroplankton), and fish eggs and larvae (ichthyoplankton). Most nuclear power plants have been required to monitor for entrainment effects during the initial years of operation. Entrainment impacts to phytoplankton and zooplankton are considered to be of small significance if there is no evidence of reductions of populations of phytoplankton or zooplankton.

Studies of the effects of entrainment at several nuclear power plants are reviewed in Appendix F. None of the agencies consulted expressed concern about entrainment of phytoplankton or zooplankton (Appendix F). Because of large numbers and short regeneration times of phytoplankton and zooplankton, impacts of entrainment on these organisms have rarely been documented outside the immediate vicinity of the plant and are considered to be of little consequence (Schubel and Marcy 1978; Hesse et al. 1982; Kennish et al. 1984; MDNR 1988; MRC 1989; EPRI EA-1038).

The effects of entrainment at nuclear plants are not expected to cause or contribute to cumulative impacts to populations of zooplankton or phytoplankton. The effects of phytoplankton and zooplankton entrainment are localized (i.e., the affected areas are smaller than the distances between power plants) and are not expected to contribute to cumulative impacts because generation times of plankton are rapid. Review of the literature and operational monitoring reports did not reveal evidence of cumulative impacts from entrainment of phytoplankton and zooplankton. Further, consultation with utilities and agencies during preparation of the draft GEIS, as well as their comments on the draft GEIS (NUREG-1529), revealed no concerns about cumulative impacts of phytoplankton and zooplankton entrainment.

Reviews of the literature, monitoring reports, and consultation with agencies and utilities did not reveal any evidence of mitigation measures that had been required to correct problems with entrainment of phytoplankton and zooplankton. Because cooling system operations are not expected to change during the license renewal term, additional mitigation is not expected to be warranted.

Entrainment of phytoplankton and zooplankton is expected to have a small impact on populations of these organisms in the source body of water at any plant. No change in operation of the cooling system is expected during the license renewal term, so no change in effects on entrainment of phytoplankton and zooplankton is anticipated. Effects on entrainment of phytoplankton and zooplankton could be reduced by changing to a closed cycle cooling system or by reducing the plant's generation rate. However, because the effects on entrainment of phytoplankton and zooplankton are considered to be impacts of small significance and because they would be costly to implement, the staff does not consider the implementation of these potential mitigation measures to be warranted. This is a Category 1 issue.

4.2.2.1.2 Entrainment of Fish and Shellfish

The effects of entrainment on aquatic resources were considered by NRC at the time of original licensing and are periodically reconsidered by EPA or state water quality permitting agencies in the development of NPDES permits and 316(b) demonstrations (Section 4.2.1.1.2). Although significant adverse entrainment effects have not been demonstrated at most facilities, the entrainment of fish and shellfish in early life stages remains an issue at some nuclear power plants with once-through cooling systems. Agencies consulted for this GEIS expressed concerns about the impacts of entrainment at Zion, Salem, Oyster Creek, Indian Point, Calvert Cliffs, Millstone, Yankee Rowe, and Surry. Several licensed nuclear power plants (e.g., Indian Point, Oyster Creek, Comanche Peak, Salem, and Zion) have unresolved 316(b) determinations. At some power plants, fish populations have been restored in the years since issuance of the original license and, as a result, more fish are now susceptible to entrainment. At other nuclear power plants (Beaver Valley, Susquehanna, Three Mile Island, and Peach Bottom), an agency expressed concern about future entrainment during the license renewal period as restoration efforts continue to increase fish populations (James Gillett, Deputy Regional Director, U.S. Fish and Wildlife Service, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, July 27, 1990).

The impacts of fish and shellfish entrainment are small at many plants, but they may be moderate or even large at a few plants with once-through cooling systems. Further, ongoing restoration efforts may increase the numbers of fish susceptible to intake effects during the license renewal period, so that entrainment studies conducted in support of the original license may no longer be valid. For these reasons, the entrainment of fish and shellfish is a Category 2 issue for plants with once-through cooling systems.

4.2.2.1.3 Impingement of Fish and Shellfish

Aquatic organisms that are drawn into the intake with the cooling water and are too large to pass through the debris screens may be impinged against the screens. Mortality of fish that are impinged is high at many plants because impinged organisms are eventually suffocated by being held against the screen mesh or are abraded, which can result in fatal infection. Impingement can affect large numbers of fish and invertebrates (crabs, shrimp, jellyfish, etc.). As with entrainment, operational monitoring and mitigative measures have allayed concerns about population-level effects at most plants, but impingement mortality continues to be an issue at others. Consultation with resource agencies (Appendix F) revealed that impingement is a frequent concern at once-through power plants, particularly where restoration of anadromous fish may be affected. In several cases, such as Oyster Creek, Salem, Surry, and Prairie Island, significant modifications were made to the intake structure to substantially reduce mortality due to impingement. Impingement is an intake-related effect that is considered by EPA or state water quality permitting agencies in the development of NPDES permits and 316(b) determinations. Appendix F examines studies of the effects of impingement of fish at several nuclear power plants. The impacts of impingement are small at many plants but may be moderate or even large at a few plants with once-through cooling systems. For this reason, the impingement of fish and shellfish is a Category 2 issue.

4.2.2.1.4 Thermal Discharge Effects

The heated effluents of steam-electric power plants can cause mortality among fish and other aquatic organisms from either thermal discharge effects or cold shock. Temperatures high enough to kill organisms are found in the cooling water systems, often in the area nearest the effluent discharge structure. Because thermal effects were among the earliest potential impacts identified for power plant operation, a great deal of research and regulatory effort has been aimed at understanding and controlling thermal discharges. Upper lethal temperatures (and various other expressions of temperature tolerance) have been determined for many important species and life stages. As a result, conditions that can lead to thermal discharge effects are relatively predictable.

Mitigative measures have been employed at many power plants to reduce the potential for thermal discharge effects. They can be minimized by lowering effluent temperature before discharge to natural waters (e.g., with cooling ponds) or by enhancing rapid mixing and heat dissipation (through high-velocity jet diffusers).

Each permitting state has developed mixing zone criteria and thermal discharge limits for steam-electric power plants. If the plant meets these criteria, no 316(a) determination is required. If the facility fails to meet the state temperature limits, the facility must submit data demonstrating that the discharge will ensure the protection and propagation of a balanced indigenous population of shellfish, fish, and wildlife [i.e., a 316(a) demonstration]. For plants within the state limits, the implicit assumption is made that a balanced indigenous population is ensured. The NPDES permit required for each power plant contains discharge temperature limits that are based on either state standards or site-specific studies of thermal effects [i.e., 316(a) demonstrations]. Nevertheless, thermal discharges continue to be an issue at some once-through nuclear power plants (see agency consultation, Appendix F). In some cases, the facility is being extensively modified to minimize thermal-discharge-related effects (e.g., installation of cooling towers at Crystal River). In others, the 316(a) determination has not been approved and is now under review. Studies of thermal discharge effects at selected nuclear power plants that employ once-through cooling systems are described in Appendix F.

Based on the research literature, monitoring reports, and agency consultations, the potential for thermal discharges to cause thermal discharge effect mortalities is considered small for most plants. However, impacts may be moderate or even large at a few plants with once-through cooling systems. For example, thermal discharges at the Crystal River Nuclear Plant are considered by the agencies to have damaged the benthic invertebrate and seagrass communities in the effluent mixing zone around the discharge canal; as a result, helper cooling towers have been installed to reduce the discharge temperatures (Appendix F.4.7). Conversely, at other plants it may become advantageous to increase the temperature of the discharge in order to reduce the volume of water pumped through the plants and thereby reduce entrainment and impingement effects (see discussion of San Onofre Nuclear Generating Station in Appendix F.4.6). Because of continuing concerns about thermal discharge effects and the possible need to modify thermal discharges in the future in response to changing environmental conditions, this is a Category 2 issue for plants with once-through cooling systems.

4.2.2.1.5 Cold Shock

Cold shock occurs when organisms that have been acclimated to warm water (e.g., in a discharge canal in winter) are exposed to sudden temperature decreases when artificial heating ceases. Such situations may occur when a single-unit power plant suddenly shuts down in winter (Coutant 1977) or when winds or currents shift a thermal plume that was occupied by fish or benthic invertebrates seeking warm water. As with heat effects, the conditions that can lead to cold shock are relatively well understood—if it is a function of acclimation temperature, final (cold ambient) temperature, and exposure times—and therefore can be mitigated if needed. Cold shock mortalities have occurred, for example, at the Haddam Neck (Connecticut Yankee) plant (S. W. Gorski, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, July 18, 1990) and at the Prairie Island and Monticello nuclear generating plants (P. M. Bailey, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, July 3, 1990). Cold-shock mortalities are relatively rare and usually involve small numbers of fish. Population-level effects have not been demonstrated. Where necessary, the discharge structure or the plant operating procedures have been modified to reduce cold-shock effects. Structural modifications could include constructing a barrier to prevent fish from residing in the discharge canal or designing a high-velocity discharge to encourage rapid mixing and to discourage residence in the plume. Operational measures that could be used to reduce the risk of cold shock by gradually reducing the amount of warm water discharged in winter include gradual shutdowns or shutdowns of only one unit of a multi-unit power plant at a time.

Impacts of cold shock are considered to be of small significance if populations of aquatic organisms in the vicinity of the plant are not reduced. Based on review of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft GEIS, cold-shock-related mortalities of aquatic organisms have been a problem at few existing nuclear power plants. Operational and structural mitigation measures have been effective at the plants that experienced cold shock mortalities. Because mitigation has been effective in those few cases where cold shock has been a problem, effects are considered to be of small significance for all plants. Cold shock is not expected to contribute to cumulative impacts because the potential area of impact is so small and because mitigation to prevent cold shock mortalities at individual power plants also reduces the likelihood that thermal discharges would contribute to cumulative effects. No change in operation of the cooling system is expected during the license renewal term, so no change in potential for cold shock is anticipated. Effects of cold shock could be reduced by changing to a closed cycle cooling system or by reducing the plant's generation rate. However, because the effects of cold shock are considered to be impacts of small significance and these changes would be costly, the staff does not consider the implementation of these potential mitigation measures to be warranted. Cold shock is a Category 1 issue.

4.2.2.1.6 Effects of Movements and Distribution of Aquatic Organisms

Heated effluents can affect aquatic populations in more subtle ways by altering their distribution, growth, or movements. Changes in benthic community composition such as losses of seagrass or other macrophytes can alter the habitat available to aquatic animals. Warm water can increase the metabolic rates of aquatic biota, a method often used in aquaculture to achieve high growth and production rates. However, in the absence of adequate food supplies, elevated metabolic rates can lead to a poor condition of the fish inhabiting heated areas.

It had been suggested that thermal plumes could constitute a barrier to migrating fish if the mixing zone covered a substantial area and exceeded the fish avoidance temperatures. However, studies of effects of heated effluents on Columbia River salmon (Nakatani 1969) and anadromous fish in the Chesapeake Bay (e.g, shad and striped bass) (MDNR 1988) have concluded that fish migration routes were not blocked. Most migrating adult American shad move in the lower half of the water column (Witherell and Kynard 1990) and are therefore unlikely to be deterred by a thermal plume at the surface.

Impacts from potential thermal plume barriers are considered to be of small significance if fish migrations are not blocked and populations of aquatic organisms in the vicinity of the plant are not reduced. Based on review of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft GEIS, thermal plume barriers have not been a problem at any existing nuclear power plants. Heat is rapidly dissipated from power plant discharge plumes, so that effects would only be localized and therefore of small significance for all plants. These effects are not expected to contribute to cumulative impacts. No regulatory agency expressed concerns about cumulative impacts to migrations of aquatic organisms. No change in operation of the cooling system is expected during the license reneqal term, so no change in the potential for a thermal plume barrier to migrating fish is anticipated. Effects of a thermal plume barrier to migrating fish could be reduced by changing to a closed cycle cooling system or by reducing the plant's generation rate. However, because the effects of a thermal plume barrier to migrating fish are considered to be impacts of small significance and because the changes would be costly to implement, the staff does not consider the implementation of these potential mitigation measures to be warranted. Thus thermal plume barriers to migrating fish are a Category 1 issue.

The temperature regime of a body of water is an important component of habitat available to aquatic organisms. By altering the temperature regime, heated effluents can increase or decrease the amount of available habitat. For example, the abundance of coldwater species may be constrained near the southern limits of their distribution by thermal power plant effluents because the heated water exceeds the temperature tolerance of the species. By the same token, heated effluents can extend the northern range of warmwater species by providing thermal refuges during the winter. For example, Stauffer et al. found that blue tilapia, a tropical exotic fish species from Africa and southern Asia, were able to survive low winter water temperatures in the Susquehanna River, Pennsylvania, by congregating in thermal effluents. On a larger scale, the effects of global warming on water temperatures and on the distribution and productivity of aquatic organisms is being studied (Regier et al. 1990). At present, heated discharges from power plants influence a relatively small area of the affected bodies of water so that significant changes to the geographic distribution of a species are unlikely.

Impacts of thermal discharges on geographic distribution of aquatic organisms are considered to be of small significance if populations in the overall region are not reduced. Based on review of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft GEIS, thermal discharges have not been shown to constrain the regional geographic distribution of aquatic organisms at any existing nuclear power plants. Localized reductions in coldwater species or increases in warmwater species are possible, but the effects are limited to small areas and have not altered larger geographic distributions. Effects are considered to be of small significance for all plants. Heat is rapidly dissipated from power plant discharge plumes, and heated plumes are small relative to the size of the waterbody. Consequently, effects would only be localized, and cumulative impacts on geographic distribution would not be expected. No regulatory agency expressed concerns about cumulative impacts on geographic distribution of aquatic organisms. No change in operation of the cooling system is expected during the license renewal term, so no change in effects on geographic distribution of aquatic organisms is anticipated. Effects on geographic distribution of aquatic organisms could be reduced by changing to a closed cycle cooling system or by reducing the plant's generation rate. However, because the effects on geographic distribution of aquatic organisms are considered to be impacts of small significance and because these changes would be costly, the staff does not consider the implementation of these potential mitigation measures to be warranted. Effects of localized thermal discharges on geographic distribution of aquatic organisms are a Category 1 issue.

4.2.2.1.7 Premature Emergence of Aquatic Insects

Heated discharges from power plants can impact aquatic insects that inhabit the bottom areas influenced by the thermal plume. Impacts can range from direct mortality (e.g., when lethal temperatures are exceeded) to sublethal effects (e.g., increases in growth rates; decreases in development times; changes in body size and fecundity). Different species have different tolerances for altered temperature regimes, so that the benthic invertebrate community in the discharge area is rarely eliminated; but it may become dominated by a reduced number of taxa that are tolerant of higher temperatures. Because thermal plumes tend to be buoyant, often the bottom area of the receiving body of water that is affected by elevated temperatures is relatively small, and the effects on the benthic invertebrate community are localized.

Premature emergence of aquatic insects can result from heated effluents coming in contact with benthic habitats (e.g., in the discharge canal or along the shoreline near the discharge) and accelerating the development of immature forms. Adult insects emerge from the water before the normal seasonal cycle and may be unable to reproduce. Although this phenomenon has been observed near power plants, the area likely to be affected by thermal effluents would be a small part of the total lake or river bottom area available for production of aquatic insects. In addition, most aquatic insects have adult upstream migration flights that compensate for normal downstream drift of immature stages (Hynes), so that such localized effects on reproduction through this mechanism are inconsequential (Coutant 1981).

Effects of thermal discharges on premature emergence of aquatic insects are considered to be of small significance if changes are localized and populations in the receiving waterbody are not reduced. Based on reviews of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft GEIS, thermal discharges have not been shown to cause reductions in the overall populations of aquatic insects near any existing nuclear power plants. Localized mortalities among heat-intolerant insect species occur in the thermal mixing zone, but the effects are limited to small areas and do not alter insect communities in larger geographic areas. Because heat in the discharged water is readily dissipated to the atmosphere, effects from this and other heated effluents would not be expected to contribute to cumulative impacts. Effects are considered to be of small significance for all plants. No change in operation of the cooling system is expected during the license renewal term, so no change in effects on emergence of aquatic insects is anticipated. Effects on emergence of aquatic insects could be reduced by changing to a closed cycle cooling system or by reducing the plant's generation rate. However, because the effects on emergence of aquatic insects are considered to be impacts of small significance and because these changes would be costly, the staff does not consider the implementation of these potential mitigation measures to be warranted. Effects of thermal discharges on premature emergence of aquatic insects is a Category 1 issue.

4.2.2.1.8 Gas Bubble Disease

Rapid heating of water in the condenser cooling system decreases the solubility and increases saturation levels of dissolved gases. The supersaturation of nitrogen gas has led to incidents of "gas bubble disease" (GBD) in the discharge areas of steam-electric power plants. The mechanisms by which gas supersaturation and GBD occur at steam-electric power plants (as well as under other conditions such as in the tailwaters of hydroelectric power plants) have been described by Wolke et al. Discharge configurations that do not allow rapid mixing of the effluent with the receiving waters may allow organisms to reside in the supersaturated effluent for long periods (Coutant 1981). As a result of equilibrating with the effluent, the tissues of aquatic organisms become supersaturated as well. Eventually, this unstable condition breaks down, and bubbles form inside the animal, most obviously in the fins and the eyeball (Wolke et al.). Fish mortalities generally occur at gas supersaturation levels above 110 to 115 percent (EPA 440/5-86-001).

GBD in the discharge of a steam-electric power plant (the Marshall Steam Station on Lake Norman) was first reported by DeMont and Miller and has been observed at other power plants since that time. GBD at the Pilgrim Nuclear Power Station caused a loss of 43,000 Atlantic menhaden in 1973, and another 5,000 in 1976 [Boston Edison Company, response to NUMARC survey (NUMARC 1990)]. The problem appears to be greatest at power plants that have discharge canals where fish may reside for extended periods of time (i.e., long enough to equilibrate with supersaturated effluents). The reported incidences of GBD at the Waukegan Generating Station (a coal-fired plant on Lake Michigan; Otto), the Marshall Steam Station (a coal-fired plant on Lake Norman; DeMont and Miller), and the Pilgrim Nuclear Power Station all involved fish residing in discharge canals. Ensuring the rapid mixing of effluents with receiving waters (e.g., with a jet diffuser system) appears to prevent GBD mortalities by inhibiting residence in the thermal plume (Lee 1984). Alternatively, measures to prevent residence of fish in discharge canals may be effective. Emplacement of a barrier net to exclude fishes from the Pilgrim discharge canal has prevented GBD mortalities at that plant since 1976 [Boston Edison Company, response to NUMARC survey (NUMARC 1990)]. The GBD problem has been mitigated at the one nuclear power plant where large numbers of fish were affected.

Impacts of GBD are considered to be of small significance if populations of aquatic organisms in the vicinity of the plant are not reduced. Based on review of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft GEIS, GBD-related mortalities of aquatic organisms have not been a problem at most existing nuclear power plants; and operational and structural mitigation measures have been effective at those plants that experienced GBD mortalities during the initial license period. Effects are considered to be of small significance for all plants. Mitigation to prevent GBD mortalities at individual power plants also reduces the likelihood that thermal discharges would contribute to cumulative effects; no regulatory agency expressed concerns about the contribution of existing nuclear plants to cumulative impacts of GBD. No change in operation of the cooling system is expected during the license renewal term, so no change in effects on GBD is anticipated. Effects on GBD could be reduced by changing to a closed cycle cooling system or by reducing the plant's generation rate. However, because the effects on GBD are considered to be impacts of small significance and because such charges would be costly, the staff does not consider the implementation of these potential mitigation measures to be warranted. Gas bubble disease is a Category 1 issue.

4.2.2.1.9 Low Dissolved Oxygen in the Discharge

A power plant may aggravate the biological effects of low dissolved oxygen (DO) concentrations in the source water by adding a heat load to water with preexisting low DO levels. Aquatic biota below the discharge are then stressed by both higher temperatures (which increase the metabolic rate and the need for oxygen) and preexisting suboptimal oxygen levels. Concern about the effects of low DO concentrations in the heated discharge of the Sequoyah Nuclear Plant on downstream mussel beds and sauger reproduction has been expressed by the Tennessee Division of Water Pollution Control (Ann McGregor, Tennessee Division of Water Pollution Control, telephone interview with G. F. Cada, ORNL, Oak Ridge, Tennessee, May 30, 1990). Cool, hypolimnetic water released from Watts Bar reservoir, upstream from the Sequoyah Nuclear Plant, often had low DO concentrations. The temperature of the condenser cooling water rises approximately 14°C when both units are operating without cooling towers. As a result, a mean net decrease of 0.8 mg/L of DO concentration was measured in the cooling water, which under extreme low flow conditions could reduce the mean water column DO concentration in the Chickamauga reservoir near the Sequoyah Nuclear Plant by approximately 0.5 mg/L (TVA 1990). Water quality modeling indicated that increasing the DO of Watts Bar Dam releases by 2 mg/L would improve DO concentrations through Chickamauga Reservoir by about 1 mg/L. Recent changes in the release schedule of Watts Bar Dam appear to have reduced the stagnation of water near the Sequoyah Nuclear Plant and alleviated concern about low DO effects (Tom Roehm, Tennessee Division of Water Pollution Control, telephone interview with G. F. Cada, ORNL, Oak Ridge, Tennessee, November 16, 1992).

Impacts of low DO concentrations in the discharge are considered to be of small significance if populations of aquatic organisms in the vicinity of the plant are not reduced. Based on review of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft GEIS, low DO concentrations have not been a problem at most existing nuclear power plants, and operational mitigation measures have been effective at the one plant that experienced problems during the initial license period. Effects of low DO concentrations are considered to be of small significance for all plants. Water will be reaerated by turbulent diffusion and/or photosynthesis, so far-field effects are not expected. Mitigation to prevent low DO concentrations in the vicinity of the power plant will also reduce the likelihood of significant cumulative impacts; none of the resource agencies expressed an ongoing concern about the contribution of existing power plants to cumulative impacts of low DO concentrations. No change in operation of the cooling system is expected during the license renewal term, so no change in effects of low DO concentrations is anticipated. Effects of low DO concentrations could be reduced by changing to a closed cycle cooling system or by reducing the plant's generation rate. However, because the effects of low DO concentrations are considered to be impacts of small significance and because these changes would be costly, the staff does not consider the implementation of these potential mitigation measures to be warranted. Low DO concentrations in the thermal discharge are a Category 1 issue.

4.2.2.1.10 Losses from Parasitism, Predation, and Disease

Sublethal power plant stresses may alter predator-prey interactions in the receiving body of water. Aquatic organisms that are stunned but not killed by entrainment, impingement, or thermal effects may still suffer "indirect" mortality through increased susceptibility to predators. Numerous laboratory studies have been carried out to evaluate the level of indirect mortality that might occur following heat and cold shocks or entrainment (reviews in ORNL/TM-7801; Coutant 1981). These studies have commonly demonstrated increased susceptibility to predation, but field evidence of such effects is often limited to anecdotal information such as observations of enhanced feeding activity of seagulls and predatory fish near power plant outfalls. For example, Barkley and Perrin (1971), and CONF-730505 reported increased concentrations of predators feeding on forage fish attracted to thermal plumes. Neither quantification of the levels of stress needed to increase predation rates, nor prediction of the subsequent population- and community-level effects of such changes can be made easily in the field. It is likely that operation of once-through cooling systems will cause some changes in predator-prey relationships, but the best evidence for impacts (or lack of impacts) may come from long-term monitoring of fish populations. Neither the literature reviews nor consultations with agencies and utilities (Appendix F) have revealed studies that demonstrate population- or community-level effects from power-plant-induced alterations of predator-prey relationships.

Elevated water temperatures in power plant discharges have been hypothesized to increase the susceptibility of fish to diseases and parasites. Langford cites a number of factors that could contribute to such an effect, including the tendency for fish to congregate in the heated discharge area in greater than normal concentrations, increased stresses on fish in warmer water that makes them more prone to infection, and the ability of some diseases and parasites to develop faster at higher temperatures. Additionally, it has been suggested that stress and injury from entrainment and impingement contribute to increased susceptibility of fish to disease, parasites, and predation. Coutant (1981) noted that although some studies of increased disease and parasitism in heated waters have found localized effects, most were not adequately designed to determine the significance of the effects to the overall population. The greatest risks appear to be associated with changes in animal concentrations; crowding can occur among fish that are attracted to heated effluents in the winter or that avoid heated water in the summer by occupying limited cool-water refugia. Crowding increases the chances of exposure to infectious diseases and may also lead to other stresses (decreased food supply or reduced oxygen concentrations) that increase susceptibility to disease (Coutant 1987). Despite limited laboratory studies that confirm this phenomenon, population-level effects in the vicinity of plants have not been observed.

Effects of sublethal stresses on the susceptibility of aquatic organisms to predation, parasitism, and disease are considered to be of small significance if changes are localized and populations in the receiving waterbody are not reduced. Based on reviews of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft GEIS, these forms of indirect, power plant-induced mortality have not been shown to cause reductions in the overall populations near any existing nuclear power plants. Effects are considered to be of small significance for all plants. Although sublethal power plant stresses could contribute to cumulative impacts experienced by aquatic biota, monitoring has revealed no evidence for significant effects; the regulatory and resource agencies consulted in the preparation of this GEIS did not express concerns about the contribution of sublethal power plant stresses to cumulative impacts. No change in operation of the cooling system is expected during the license renewal term, so no change in effects of sublethal stresses is anticipated. Effects of sublethal stresses could be reduced by changing to a closed cycle cooling system or by reducing the plant's generation rate. However, because the effects of sublethal stresses are considered to be impacts of small significance and because the changes would be costly, the staff does not consider the implementation of these potential mitigation measures to be warranted. This is a Category 1 issue.

4.2.2.1.11 Stimulation of Nuisance Organisms

A variety of nuisance organisms or nonnative species may become established or proliferate as a result of power plant operations, including fouling organisms such as the Asiatic clam (*Corbicula* sp.) and the recently introduced zebra mussel, *Dreissena polymorpha*. Aspects of the operation of the power plants (e.g., warm temperatures or high flow rates that bring food to filter-feeding organisms) may be conducive to the growth and development of these organisms. *Corbicula* sp. and zebra mussels may become so abundant as to cause operational difficulties for the power plant and may out-compete native clams and mussels in thermally enriched waters. A population of tropical, non-native blue tilapia became established in the Susquehanna River in Pennsylvania by congregating in thermal effluents during the winter. Exposure to rapid temperature decreases (cold shock) killed these fish and eradicated the population from the vicinity of a steam-electric power plant (Stauffer et al.).

Langford (1983) reports a number of instances in which wood-boring crustaceans and mollusks, notably "shipworms," have caused concern in British waters. Although increased abundance of shipworms in the area influenced by heated power plant effluents caused substantial damage to wooden structures, replacement of old wood with concrete or metal structures eliminated the problem. Langford concluded that increased temperatures could enhance the activity and reproduction of wood-boring organisms in enclosed or limited areas but that elevated temperature patterns were not sufficiently stable to cause widespread effects.

In the United States, the influence of the operation of Oyster Creek Nuclear Generating Station on shipworm abundance and distribution has been extensively studied (see summary in Richards et al. 1984). Although numerous studies have varied somewhat in their conclusions, there is agreement that heated effluents from the plant increased the distribution and abundance of the nonnative, tropical-subtropical wood-boring species *Teredo bartschi* (Kennish et al. 1984). This species has not been found in Oyster Creek or Barnegat Bay since 1982, perhaps because of low water temperatures in Oyster Creek during a station outage in the winter of 1981–82 and the pathological effects of a parasite [GPU Nuclear Corporation response to NUMARC survey (NUMARC 1990)]. In addition, the removal of substantial amounts of driftwood and the replacement of untreated structural wood is thought to have contributed to reducing the populations of wood-boring organisms in Oyster Creek. No other concerns about nuisance organisms were cited by the regulatory or resource agencies contacted for this GEIS (Appendix F). Measures taken by licensees to control nuisance species (e.g., increased chlorination or use of molluskicides) may result in impacts on other species. This impact is addressed in Section 4.2.1 and is also controlled by the NPDES permitting procedures.

The effects of stimulating the growth of nuisance organisms are considered to be of small significance to aquatic resources if these organisms are restricted to the condenser cooling system (e.g., Asiatic clam; zebra mussel) or do not proliferate beyond the immediate vicinity of the plant. Based on review of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft GEIS, nuisance organisms such as Asiatic clam may be an operational problem, but they have not impacted aquatic resources near most existing nuclear power plants. Mitigation measures were effective at the one plant that experienced problems with nuisance organisms (shipworms). Effects are considered to be of small significance for all plants. The regulatory and resource agencies consulted in the preparation of this GEIS did not express concerns about the contribution of power plant operations to other activities that might encourage the growth of nuisance organisms (i.e., cumulative effects). No change in operation of the cooling system is expected during the license renewal term, so no change in the growth or distribution of nuisance organisms is anticipated. Effects on nuisance organisms could be reduced by changing to a closed cycle cooling system or by reducing the plant's generation rate. However, because the effects on the growth of nuisance organisms are considered to be impacts of small significance and because such changes would be costly, the staff does not consider the implementation of these potential mitigation measures to be warranted. The stimulation of nuisance aquatic organisms by operation of existing power plants is a Category 1 issue.

4.2.2.2 Summary

The issues and the need for these issues to be addressed in license renewal applications of existing nuclear power plants with once-through cooling systems are summarized in Table 4.1. The operational experience of existing nuclear power plants indicates that many early aquatic resource concerns have not materialized as problems at any facility. Neither the published literature nor the responses of regulatory and resource agencies have revealed concerns about such early issues as phytoplankton and zooplankton entrainment and premature emergence of aquatic insects living in thermal discharges. Although statistically significant localized effects of these stresses have occasionally been demonstrated, long-term or far-field impacts have not been documented. Other issues (e.g., lowered DO concentrations, discharge of heavy metals, cold shock, and stimulation of nuisance organisms) were problems at a few nuclear power plants with once-through cooling systems but have since been mitigated.

Table 4.1 Significance of aquatic resources impacts for license renewal of existing nuclear power plants that use once-through cooling systems

Issue	Impact significance[a]
Water quality, hydrology, and use issues	
Water use conflicts	1
Altered current patterns at intake and discharge structures	1
Altered salinity gradients	1
Temperature effects on sediment transport capacity	1
Altered thermal stratification of lakes	1
Scouring from discharged cooling water	1
Eutrophication	1
Discharge of chlorine or other biocides	1
Discharge of metals in waste water	1
Discharge of sanitary wastes and minor chemical spills	1
Effects of consumptive water use on riparian communities	1
Aquatic ecology	
Impingement of fish and shellfish	2
Entrainment of fish and shellfish early life stages	2
Entrainment of phytoplankton and zooplankton	1
Thermal discharge effects	2
Cold shock	1
Thermal plume barrier to migrating fish	1
Distribution of aquatic organisms	1
Premature emergence of aquatic insects	1
Stimulation of nuisance organisms (e.g., shipworms)	1
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	1
Gas supersaturation (gas bubble disease)	1
Low dissolved oxygen in the discharge	1
Accumulation of contaminants in sediments or biota (Section 4.2.1 and 4.2.4)	1

[a]A 1 means impact significance expected to be small at all sites. A 2 means that the impact may be of moderate or large significance at some sites.

Some aquatic resource issues warrant further monitoring and, in some cases, mitigative measures to define and correct adverse impacts. The entrainment and impingement of fish and the discharge of large volumes of heated effluents into small or warm ambient waters were a source of concern at some nuclear power plants. Such issues were examined and resolved through either the NEPA process during the licensing of the facility or the mechanisms of NPDES permitting and associated 316(a) and (b) determinations. They either were found acceptable or mitigated. For some plants with once-through cooling systems, the large volumes of water withdrawn, heated, and discharged back to the receiving water may cause adverse effects to fish and shellfish populations during the license renewal term. Because impacts of entrainment of fish and shellfish, impingement, and thermal discharge effects could be small, moderate, or large, depending on the plant, these are Category 2 issues for plants with once-through cooling systems. These issues will need to be analyzed in the supplemental NEPA document at the time of license renewal.

4.3 COOLING TOWERS

This section introduces cooling towers and their emissions (Section 4.3.1) and then evaluates the impacts of the emissions on surface water and groundwater (Section 4.3.2), aquatic ecology (Section 4.3.3), agricultural crops (Section 4.3.4), terrestrial ecology (Section 4.3.5, which also includes bird collisions with cooling towers), and human health (Section 4.3.6). Impacts of cooling-tower noise are also addressed (Section 4.3.7). Each section that evaluates impacts (Sections 4.3.2–4.3.7) provides a conclusion that defines the significance of the impacts. These conclusions are based on reviews of cooling-tower data available for towers at specific nuclear plants as well as for other cooling towers (e.g., those at coal-fired plants).

4.3.1 Introduction

Mechanical- and natural-draft wet cooling towers transfer waste heat to the atmosphere primarily by evaporating water. Natural-draft towers are generally up to 160 m (520 ft) in height, whereas mechanical-draft towers are generally less than 30 m (100 ft) tall (Roffman and Van Vleck 1974). Because of the large cooling capacity of natural-draft towers, only one such tower is required for each reactor unit; but two or more mechanical-draft towers are required for equivalent cooling.

Most of the water lost from a cooling tower escapes to the atmosphere as water vapor in the exhaust flow. About 10 percent of the vapor recondenses after release, forming the visible part of the plume leaving the tower (Golay et al. 1986). Drift droplets of cooling water are also entrained in the air stream inside the tower and escape directly into the atmosphere. A particulate solid drift material remains after droplet evaporation. The drift contains varying amounts of salts, biocides, and microorganisms.

Natural-draft towers release drift and moisture high into the atmosphere where they are dispersed over long distances. Local impacts are more likely to occur with mechanical-draft towers because the plume is not dispersed over as great an area. The visible moisture plume from a natural-draft cooling tower may be 20 to 30 percent longer than that from comparable mechanical-draft towers (Roffman and Van Vleck 1974). Icing of vegetation and roads can occur near mechanical draft towers when fog is present and temperatures are below freezing. Much of the drift eventually deposits on the earth. The atmospheric transport of drift and the amount of deposition to the earth has been estimated for most nuclear plants through the use of computer models. Actual measurements of drift deposition have been collected at only a few nuclear plants. These measurements indicate that, beyond about 1.5 km (1 mile) from nuclear plant cooling towers, salt deposition is not significantly above natural background levels.

4.3.2 Surface Water Quality and Use

Sections 4.3.2 and 4.3.3 review the past and ongoing impacts on aquatic resources caused by the operation of nuclear power plants with cooling towers. Any ongoing impacts will probably continue into the license renewal term because the cooling system design and operation will not change as a result of license renewal. Judgments about the significance of these issues during the license renewal terms are based on published information, agency consultation, and information provided by the utilities (Appendix F) applicable to every nuclear power plant in the United States. The conclusions drawn in Sections 4.3.2 and 4.3.3 apply to all nuclear power plants with cooling towers.

4.3.2.1 Water Use

Two factors may cause water-use and water-availability issues to become important for some nuclear power plants that use cooling towers. First, the relatively small rates of cooling water withdrawal and discharge allowed some power plants with cooling towers to be located on small bodies of water that are susceptible to droughts or competing water uses. Second, closed-cycle cooling systems evaporate cooling water, and consumptive water losses may represent a substantial proportion of the flows in small rivers. Loss of a substantial portion of flow from a small stream as a result of evaporative losses from a cooling tower will reduce the amount of habitat for fish and aquatic invertebrates. Off-stream water uses, such as power plant consumption, must be regulated to ensure that important in-stream uses, such as habitat for aquatic organisms, boating, angling, and waste assimilation, are not compromised.

Consumptive water use can adversely impact riparian vegetation and associated animal communities by reducing the amount of water in the stream that is available for plant growth, maintenance, and reproduction. Riparian vegetation is defined as streamside vegetation that is structurally and floristically distinct from adjacent upland plant communities (Taylor 1982). Riparian vegetation has important ecological functions; and its importance as a resource has been widely recognized and reviewed (e.g., Brinson et al. 1981; Johnson et al. 1985). Briefly, riparian vegetation stabilizes stream channels and floodplains. It influences biogeochemical cycles, water temperature and quality, and the duration and magnitude of flooding. Riparian vegetation also provides diverse cover, food, water, reproductive habitat, and migration corridors for many aquatic and terrestrial animals. As a result, riparian zones often support a wide variety and high density of wildlife (deer, small mammals, songbirds, raptors, reptiles, and amphibians), especially in arid or urbanized areas. Riparian vegetation may be adversely affected by dewatering in a number of ways (Taylor 1982), including decreases in the width of the riparian corridor, changes in species and community diversity, increased susceptibility to flooding, changes in tree canopy cover, lower tree basal area, and lower seedling densities. Impacts to wildlife occur as a direct or indirect result of degradation of riparian habitats. Such dewatering effects are most apparent in the arid and semi-arid West; in the eastern United States, dewatering effects generally involve more subtle changes in community composition because of the higher precipitation, humidity, and soil moisture and the lower water stress conditions that prevail.

Limerick Generating Station, located on the Schuylkill River at Pottstown, Pennsylvania, is an example of a plant with a closed-cycle cooling system that is subject to water availability constraints because of in-stream-flow requirements in a smaller river, controversy over water use related to interbasin transfer, competing water uses, and water-related agreements between utilities. Aquatic resource issues identified include (1) water quality and low-flow problems in the Schuylkill River; (2) water availability conflicts with downstream water users; (3) increased in-stream flow requirements, particularly with respect to continuing efforts to improve the water quality of the Schuylkill River and to reintroduce American shad into the river; and (4) concerns over saltwater movement upstream in the Delaware River as the result of upstream water use (Margaret A. Reilly, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee May 24, 1990; D. T. Guise, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, July 3, 1990).

Limerick is in one of the fastest growing regions in Pennsylvania, which is experiencing heavy residential development and water demands for domestic, existing industrial, and developing industrial uses (Joseph Hoffman, letter to V. R. Tolbert, ORNL, Oak Ridge, Tennessee, August 27, 1990). Limerick is permitted to withdraw up to 13 percent of the minimum flow of the Schuylkill River and a major portion of the flow of Perkiomen Creek for cooling tower makeup. Only 5 percent of the 1.8–2.0 m^3/s (65–70 ft^3/s) withdrawn from the Schuylkill River when the flow is greater than 15 m^3/s (530 ft^3/s) is returned to the river. This loss of in-stream flow is viewed as a significant contribution to the water quality and low-flow problems in the Schuylkill River (Dennis T. Guise, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, July 3, 1990). This water-use issue may be exacerbated as efforts to reintroduce the American shad into the Schuylkill River continue. In addition to the water use from the Schuylkill River, 2 m^3/s (71 ft^3/s) of water is diverted from the Delaware River to the East Branch of Perkiomen Creek via the Point Pleasant Diversion at a rate of 2 m^3/s (71 ft^3/s); this interbasin transfer affects the achievement of the 85 m^3/s (3000 ft^3/s) minimum flow objective in the Delaware River at Trenton. The effects of the diversion are being debated through an NPDES permit appeal before the Pennsylvania Environmental Hearing Board (Dennis T. Guise, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, July 3, 1990).

The Palo Verde NGS offers another example of competing water uses that may affect continued operation of nuclear facilities that use cooling towers. Palo Verde currently uses treated effluent from the cities of Phoenix and Tolleson for cooling tower makeup water. The blowdown from the cooling towers discharges to on-site lined evaporation ponds [Arizona Public Service Company response to NUMARC survey (NUMARC 1990)]. In the absence of the power plant, part of the municipal effluent would be used for commercial purposes and the remainder discharged to the Gila River, where it would be used for groundwater recharge, irrigation, and support of riparian habitat (Jack Bale, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, May 31, 1990). According to the Arizona Game and Fish Department (Donald Turner, Arizona Game and Fish Department letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, June 29, 1990), if Palo Verde uses all of its allocation, the flow from the Gila River downstream to Gillespie Dam will be reduced, the water tables will drop significantly, and aquatic habitat and riparian vegetation will be destroyed. Sixty-nine percent of the water flowing in the Gila and Salt rivers downstream from the Ninety-First Avenue treatment plant is discharged by the treatment plant. Most if not all of the water produced by the treatment plant is committed to Palo Verde. When all three units of the plant were operating, flow in the river was significantly reduced, pools and ponds dried up, and numerous fish die-offs occurred (Donald Turner, Arizona Game and Fish Department, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, June 29, 1990).

Nuclear facilities on small bodies of water may experience water-use constraints related to availability. For example, during temporary drought periods, power plants with cooling towers may have to curtail operations if evaporative water losses exceed the capacity of small, multiple-use source bodies of water. Byron Station in Illinois withdraws water from the Rock River to supply natural-draft cooling towers. By agreement with the Illinois Department of Conservation, the withdrawal for makeup is limited to 3.5 m^3/s (125 ft^3/s) and net water consumption is limited to no more than 9 percent of the flow below 19 m^3/s (679 ft^3/s) [Commonwealth Edison Company response to NUMARC survey (NUMARC 1990)]. Duane Arnold Energy Center on the Cedar River in Iowa uses mechanical-draft cooling towers for condenser cooling and could also experience water availability constraints. The state of Iowa Department of Natural Resources currently has no water-use concerns with operation of Duane Arnold (Larry J. Wilson, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, May 22, 1990); however, the plant may possibly experience future constraints on the availability of water for consumptive use, because the surface water withdrawals within the state are projected to increase by 19 percent from 1985 to 2005 (Thamke 1990). Within Linn County, where Duane Arnold is located, water use is also projected to increase (Brian Tormee, telephone interview with V. R. Tolbert, ORNL, Oak Ridge, Tennessee, September 4, 1990).

Consultations with regulatory and resources agencies indicate that water use conflicts are already a concern at two closed-cycle nuclear power plants (Limerick and Palo Verde) and may be a problem in the future at Byron Station and the Duane Arnold Energy Center. Because water use conflicts may be small or moderate during the license renewal period, this is a Category 2 issue for nuclear plants with closed-cycle cooling systems. Related to this, the effects of consumptive water use on in-stream and riparian communities could also be small or moderate, depending on the plant, and is also a Category 2 issue.

4.3.2.2 Water Quality

Although cooling towers are considered to be closed-cycle cooling systems, concentration of dissolved salts in the makeup water—which results from evaporative water loss—requires the discharge of a certain percentage of the mineral-rich stream (blowdown) and its replacement with fresh water (makeup). The quantities of blowdown are relatively small compared with the discharges from once-through systems, typically on the order of 10 percent. Water quality impacts could occur from the elevated temperatures of the blowdown or from the concentration and discharge of chemicals added to the recirculating cooling water (to prevent corrosion and biofouling, regulate pH, etc.). A unit of water may reside in the cooling circuit for 3 to 20 cycles before being lost to evaporation or released in the blowdown stream (Coutant 1981). The concentration of total dissolved solids in the cooling tower blowdown averages 500 percent of that in the makeup water, a concentration factor that can be tolerated by most freshwater biota (ORNL/NUREG/TM-226). Dilution of the low-volume blowdown by the receiving water also reduces water quality impacts of heat and contaminants discharged from closed-cycle cooling systems.

Because of strict regulation of chemical discharges from steam-electric power plants (e.g., EPA regulations per 40 CFR Part 423), water treatment systems for cooling tower blowdown have been developed. Many of these systems recapture chemical additives for recycling in the cooling system (Coutant 1981). As noted in Section 4.2, all nuclear power plants are required to obtain an NPDES permit to discharge effluents. These permits are renewed every 5 years by the regulatory agency, either EPA or, more commonly, the state's water quality permitting agency. The periodic NPDES permit renewals provide the opportunity to require modification of power plant discharges or to alter discharge monitoring in response to water quality concerns. Utility responses to the NUMARC survey (Table F.2) indicate that such changes have been made during the plants' operation to correct water quality problems.

Impacts of cooling tower discharges are considered to be of small significance if water quality criteria (e.g., NPDES permits) are not consistently violated. In considering the effects of closed-cycle cooling systems on water quality, the staff evaluated the same issues that were evaluated for open-cycle systems (Table 4.1): altered current patterns, altered salinity gradients, temperature effects on sediment transport capacity, altered thermal stratification of lakes, scouring from discharged cooling water, eutrophication, discharge of chlorine and other biocides, discharge of other chemical contaminants, and discharge of sanitary wastes. Based on review of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft GEIS, discharge of cooling tower effluents has not been a problem at existing nuclear plants. Although occasional violations of NPDES permits have occurred at many plants (e.g., minor spills), water quality impacts have been localized and temporary. Effects are considered to be of small significance for all plants. Cumulative impacts to water quality would not be expected because the small amounts of chemicals released by these low-volume discharges are readily dissipated in the receiving waterbody. No change in operation of the cooling system is expected during the license renewal term, so no change in effects of cooling towers discharges on receiving water quality is anticipated. Effects of cooling tower discharges could be reduced by operating additional wastewater treatment systems, or by reducing the plant's generation rate. However, because the effects of cooling tower discharges on water quality are considered to be impacts of small significance and because the changes would be costly, the staff does not consider the implementation of these potential mitigation measures to be warranted. Effects of cooling tower discharges on water quality are all Category 1 issues.

4.3.3 Aquatic Ecology

Cooling towers have been suggested as mitigative measures to reduce known or predicted entrainment and impingement losses (see, for example, Barnthouse and Van Winkle 1988). The relatively small volumes of makeup and blowdown water needed for closed-cycle cooling systems result in concomitantly low entrainment, impingement, and discharge effects (see Section 4.2.2 for a more complete discussion of these effects regarding once-through cooling systems). Studies of intake and discharge effects of closed-cycle cooling systems have generally judged the impacts to be insignificant (NUREG/0720; NUREG/CR-2337). None of the resource agencies consulted for this GEIS (Appendix F) expressed concerns about the impacts of closed-cycle cooling towers on aquatic resources.

However, even low rates of entrainment and impingement at a closed-cycle cooling system can be a concern when an unusually important resource is affected. Such aquatic resources would include threatened or endangered species or anadromous fish that are undergoing restoration. For example, concern about potential impacts of the Washington Nuclear Project (WNP-2) on chinook salmon has been raised by the Washington Department of Fisheries (Cynthia A. Wilson, Washington Department of Fisheries, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, July 5, 1990). Although entrainment, impingement, and thermal discharges are not believed to be a problem at WNP-2, the importance of the Columbia River salmon stocks are such that the resource agency feels that monitoring should continue. Similarly, the Pennsylvania Fish Commission has expressed concern about future entrainment and impingement of American shad by the Limerick Generating Station, the Susquehanna Steam Electric Station, Three Mile Island Nuclear Station, and Peach Bottom Atomic Power Station (Dennis T. Guise, Pennsylvania Fish Commission, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, July 3, 1990). In all cases, losses of American shad at these power plants are minimal or nonexistent, but periodic monitoring has been recommended to ensure that no future problems occur as the anadromous fish restoration efforts continue.

It is unlikely that the small volumes of water withdrawn and discharged by closed-cycle cooling systems would interfere with the future restoration of aquatic biota or their habitats. Effects of operation of closed-cycle cooling systems on aquatic organisms are considered to be of small significance if changes are localized and populations in the receiving waterbody are not reduced. In considering the effects of closed-cycle cooling systems on aquatic ecology, the staff evaluated the same issues that were evaluated for open-cycle systems (Table 4.1): impingement of fish and shellfish, entrainment of fish and shellfish early life stages, entrainment of phytoplankton and zooplankton, thermal discharge effects, cold shock, effects on movement and distribution of aquatic biota, premature emergency of aquatic insects, stimulation of nuisance organisms, losses from predation, parasitism, and disease, gas supersaturation of low dissolved oxygen in the discharge, and accumulation of contaminants in sediments or biota. Based on reviews of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft GEIS, these potential effects have not been shown to cause reductions in the aquatic populations near any existing nuclear power plants. None of the regulatory and resource agencies expressed concerns about the cumulative effects on aquatic resources of closed cycle cooling system operations at this time, although some recommended continued monitoring in view of efforts to restore fish populations. Effects of all of these issues are considered to be of small significance for all plants. No change in operation of the cooling system is expected during the license renewal term, so no change in effects of cooling towers on aquatic biota is anticipated. Effects of entrainment, impingement, and discharges from closed-cycle cooling systems could be reduced by reducing the plant's generation rate, or by operating additional wastewater treatment systems. However, because the effects of cooling tower withdrawals and discharges on aquatic organisms are considered to be impacts of small significance and because the changes would be costly, the staff does not consider the implementation of these potential mitigation measures to be warranted. The effects of closed-cycle cooling system operation on aquatic biota are all Category 1 issues.

4.3.4 Agricultural Crops and Ornamental Vegetation

The issue addressed by this section is the extent to which the productivity of agricultural crops near nuclear plants may be reduced by exposure to salts or other effects (e.g., icing, increased humidity) resulting from cooling-tower operation. The approach to evaluating this issue was as follows: first, based on a literature review, potential impacts of salts in general (whether from cooling towers or other sources such as wind-blown salts near seashores) are described according to the rate of salt deposition to earth and the relative sensitivity of different types of crops (Section 4.3.4.1); then, the data generated by monitoring programs at a representative subset of specific nuclear plants were reviewed (Section 4.3.4.2). The subset includes 10 of the 11 nuclear power plants with mechanical-draft cooling towers. Mechanical-draft towers are the focus of this section because impacts of drift deposition and icing are more likely to occur near these towers than at natural-draft towers. Drift from natural-draft towers is released at greater heights, disperses more widely, and therefore deposits on earth at lower rates or concentrations. Data were also found and reviewed for 8 of the 17 plants with natural-draft cooling towers (Table 4.1). The coal-fired Chalk Point Plant was also included in the analysis because extensive monitoring of cooling-tower-drift effects has been conducted there and because this plant uses brackish water for cooling and represents a case with comparatively high potential for drift impacts from natural-draft towers. The only nuclear plant that has a natural-draft tower and uses brackish water for cooling is Hope Creek in New Jersey. It is included among the plants that were reviewed.

The following standard of significance is applied to the effects of cooling tower operation on agricultural crops and ornamental vegetation. The impact is of small significance if under expected operational conditions measurable productivity losses (either quantity or quality of yield) do not occur for agricultural crops; and measurable damage (either visual or to plant function) does not occur for ornamental vegetation.

4.3.4.1 Overview of Impacts

4.3.4.1.1 Ambient Salts and Cooling-Tower Drift

Agricultural crops can be affected by chemical salts and biocides in cooling tower drift and drift-induced or plume-induced ice formation. Increased fogging, cloud cover, and relative humidity resulting from cooling-tower operation have little potential to affect crops, and adverse effects have not been reported. Generally, drift from cooling towers using fresh water has low salt concentrations and, in the case of mechanical draft towers, falls mostly within the immediate vicinity of the towers (ANL/ES-53), representing little hazard to vegetation off-site. Typical amounts of salt or total dissolved solids in freshwater environments are around 1000 ppm (ANL/ES-53). In arid environments, competition for water resources can result in the use of relatively low-quality or saline water for cooling, and the potential for drift-induced damage to surrounding vegetation may be greater (McBrayer and Oakes 1982). For example, source water for cooling at Palo Verde in Arizona is withdrawn from an onsite reservoir containing treated sewage effluent of relatively high salinity. As a result, cooling tower basin water also had high salinity levels including 10,000 to 26,000 ppm total dissolved solids, 3,400 to 7,000 ppm Cl^-, and 2,700 to 8,600 ppm Na^+ (NUS-5241). High salt levels also occur at plants on the coasts or coastal bays. Brackish cooling water used by the Chalk Point coal-fired plant in Maryland contained 11,000 to 26,000 ppm total soluble salts and 6,600 to 18,000 ppm Cl^- (Mulchi and Armbruster 1983). Nuclear plants with cooling towers use fresh water, except for the Hope Creek Plant in New Jersey, which uses saline water. At the Crystal River Plant, Florida, which currently uses brackish water in once-through cooling, a helper cooling tower has been constructed to cool water in a canal that receives discharge from five fossil and one nuclear units.

Talbot (1979) has concluded that adequate estimates of natural background levels of atmospheric salt loading (naturally occurring drift) and rates of deposition thereof are not available for points remote from oceans. In field measurements at a wet cooling tower, A. Backhaus et al. (1988) estimated that up to 60 percent of the chemical contents in the sample came from atmospheric aerosols and not from the tower. Therefore, observed deposition is not all drift from cooling towers (Talbot 1979). Recent work (ORNL/TM-11121) has quantified background aerosol deposition for a dozen sites throughout the country, but deposition for most locations remains poorly known.

Salts from cooling towers are deposited on vegetation by (1) wind-driven impaction, (2) droplet and particulate fallout, and (3) rainfall (Talbot 1979; CONF-740302, 1975b). In high-salt environments such as a windy seashore, impaction is usually the most important process, delivering 10 times more salt to vegetation than does fallout. Increasing wind speeds and salt concentrations increase impaction, hence increasing vegetation injury (Talbot 1979). In most humid environments, rainwater will wash off salts deposited on vegetation (ANL/ES-53), but exposure can be significant during periods between rainfalls.

4.3.4.1.2 Effects of Salt Drift

Plants damaged by salt drift may have acute symptoms, including necrotic or discolored tissue, stunted growth, or deformities (Talbot 1979; Hoffman et al. 1987). Chronic effects are less obvious but may include some degree of chlorosis and reduced growth (Talbot 1979) or increased susceptibility to disease and insect damage (Hosker and Lindberg 1982).

Climatic conditions affect plants' ability to tolerate salt (Talbot 1979; Maas 1985). The degree of injury is related to the salt content in the leaves, but hot or dry weather conditions and water stress are critical in inducing injury (most crops can tolerate greater salt stress during relatively cool and humid weather) (Maas 1985).

Among the factors that affect the plant's foliar accumulation of salt are physical characteristics of the leaves (Maas 1985; CONF-740302, 1975d; Taylor 1980), type and concentration of salt, ambient temperature and humidity, and length of time the leaf remains wet (Maas 1985). Because salt on foliage is apparently absorbed from solution, high humidity, which retards evaporation, enhances salt uptake (CONF-740302, 1975d; McCune et al. 1977; Talbot 1979; Grattan et al. 1981). Because precipitation and dew affect salt deposition, uptake, and resultant injury, dose exposure is difficult to predict (Talbot 1979; Grattan et al. 1981; McCune et al. 1977; EPA-600/3-76-078).

Plant species and crop varieties vary significantly in their tolerance to drift deposition and to soil salinity (Talbot 1979; Maas 1985). In general, salt uptake, plant injury, and reduction in crop yield have been shown to increase with increasing levels of airborne salt or deposition and with time of exposure (CONF-740302, 1975b; Mulchi and Armbruster 1981; Maas; Grattan et al.; EPA-600/3-76-078). Some plants, however, have shown a slight increase in vegetative productivity [e.g., tobacco at < 4 kg/ha (3.6 lb/acre) per week (Mulchi and Armbruster 1983) and cotton at 8 kg/ha (7 lb/acre per week) (Hoffman et al. 1987)]. Based on experimental exposures, a yield reduction of 10 percent has been estimated for deposition levels as low as 4.7 kg/ha (4.2 lb/acre) per week to corn, a species sensitive to foliar salt injury (Mulchi and Armbruster 1981). Relationships between experimental levels of salt deposition, foliar concentrations of sodium and chloride, and corn yield show that yield may be slightly reduced even at rates as low as 2 kg/ha (1.8 lb/acre) per week (Mulchi and Armbruster 1981). Also, bush beans can have reduced yield depending on the age of plants, with older plants being most sensitive (EPA-600/3-76-078). Deposition rates near nuclear-plant towers, according to available deposition data (Section 4.3.5.1.2), appear to be generally below the rates that would affect sensitive agricultural crops.

Talbot (1979) tabulated salt deposition amounts known to induce acute toxicity symptoms in vegetation (Table 4.2). Corn was the most sensitive crop, showing injury above 1.8 kg/ha (1.6 lb/acre) per week; the least sensitive was pinto beans, showing injury above 253 kg/ha (226 lb/acre) per week. Armbruster and Mulchi (1984) showed that foliar salt deposition of 3.2 to 8.8 kg/ha (2.9 to 7.9 lb/acre) per week increased foliar chloride content and damaged foliage of corn, with the higher deposition reducing the yield of grain by as much as 11 percent. They found similar results for soybeans, with bean yields

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Table 4.2 Estimates of salt-drift deposition rates estimated to cause acute injury to vegetation

Species	Deposition above which injury is expected (kg/ha/week)
Crops and ornamental plants	
Zea mays (corn)	1.82
Glycine hispida var York (soybean)	7.28
Gossypium hirsutum (cotton)	8.0
Medicago sativa (alfalfa)	15.7
Forsythia intermedia var spectabilis (forsythia)	189.6
Phaseolus vulgaris var Pinto (pinto bean)	252.8
Albizzia julibrissin rosea (mimosa)	379.2
Koelreutaria paniculata (golden rain tree)	568.8
Native species	
Cornus florida (flowering dogwood)	1.2 (in Maryland) 47.4 (in New York)
Fraxinus americana (white ash)	1.3 (in Maryland) 18.9 (in New York)
Tsuga canadensis (Canadian hemlock)	9.4
Pinus strobus (white pine)	189.6
Quercus prinus (chestnut oak)	379.2
Robinia pseudoacacia (black locust)	379.2
Acer rubrum (red maple)	474.0
Hammamelis virginiana (witch hazel)	1042.8

Source: Adapted from Talbot 1979 and Hoffman et al. 1987.
Note: To convert kg/ha to lb/acre, multiply by 0.8924.

reduced by as much as 7 percent at the highest deposition rate.

W. C. Hoffman et al. (1987) experimentally exposed cotton and cantaloupe in the arid environment near Palo Verde to foliar salt deposition rates of 8 to 415 kg/ha (7 to 370 lb/acre) per year total salt and alfalfa to depositions up to 829 kg/ha (740 lb/acre) per year. They found foliar injury in alfalfa only at the highest deposition level but no injury to cantaloupe or cotton despite increases in foliar Na^{+} and Cl^{-}. Yields of cantaloupe and alfalfa were not reduced, but 415 kg/ha (370 lb/acre) per year reduced cotton boll production and seed cotton yield by approximately 25 percent.

The burning quality of tobacco is known to be adversely affected by elevated Cl^{-}. Experiments have shown that burning quality, or length of time the leaf will burn, is impaired by increasing experimental doses of salt deposition (Mulchi and Armbruster 1983). A 17 percent reduction in burning quality was estimated for a Cl^{-} deposition of 5 kg/ha (4.5 lb/acre) per week, based on regression relationships of deposition, leaf chloride concentration, and leaf burn (Mulchi and Armbruster 1983).

Field studies of the effects of salt drift have been conducted at the Turkey Point plant and the coal-fired Chalk Point plant. Hindawi et al. (EPA-440/5-86-001) investigated field exposures of bean and corn plants to saltwater drift from a test cooling tower and power spray module at the Turkey Point plant. Salt concentrations in tissues of bean and corn plants increased with time during three weeks of exposure and decreased exponentially with distance from the salt drift source. Some injury to leaves was visible at the site of greatest exposure.

The coal-fired Chalk Point plant has a relatively high potential impact from natural-draft cooling towers because brackish water is used for cooling. Other than the Hope Creek plant, all nuclear plants with natural-draft towers use fresh water for cooling. Deposition rates at Chalk Point were measured at 12 monitoring sites at distances of from 1.6 km to 9.6 km (1 to 6 miles) from the towers during their initial 5 years of operation (Mulchi et al. 1982). No increased deposition resulting from cooling-tower operation was detected at these distances. Deposition rates at the sites ranged from about 0.5 to 1.2 kg/ha (0.4 to 1 lb/acre) per month for NaCl, which comprises most of the solids in the brackish cooling water. Monitoring sites, which were established to study effects on agricultural crops, were not located in areas closer to the towers because no active cropland was in these areas and because the plant, located on a peninsula on the Patuxent River, is bounded by water except to the north and north-northwest. Most drift probably deposits in the river.

A study of tobacco plants 3 years after Chalk Point cooling towers began operating failed to find any increase in leaf salt content that could be attributed to drift (Mulchi and Armbruster 1983). Chloride levels in tobacco and chloride and sodium levels in corn and soybeans at 1.6 km (1 mile), the closest distance crops were grown to the Chalk Point towers, were within the range of preoperational values and were no higher than levels found up to 9.6 km (6 miles) from the towers (Mulchi et al. 1982; Mulchi and Armbruster 1983).

4.3.4.1.3 Effects on Soils

Drift deposition also has the potential to damage vegetation by soil salinization. Soil salinization does not usually occur in areas where rainfall is sufficient to leach salts from the soil profile. In arid regions, however, such as at Palo Verde, cooling tower drift has the potential to increase soil salinity and thus affect native and agricultural plants (McBrayer and Oakes 1982). Salinity of irrigated soils in arid regions may also be increased by drift, even though such soils already have a high salinity resulting from salts in irrigation water and high evaporation rates. Responses of crop plants to soil salinity appear to be poorly correlated to their tolerance to foliar-applied salts (Grattan et al. 1981; Maas 1985).

In an experiment in a more humid environment, salts were applied to soils to simulate drift deposition from the Chalk Point coal-fired plant with brackish water cooling towers. One-time applications of 14–112 kg/ha (13–100 lb/acre) NaCl affected leaf Cl^- in corn and soybeans but resulted in no visible damage or reduction in yield (Armbruster and Mulchi 1984). These soil salt treatments also increased soil pH and extractable cations (Armbruster and Mulchi 1984), but leaching by winter precipitation returned soil to pretreatment status.

In humid environments, effects of drift deposition on soils appear transitory if they can be detected at all. Field measurements of the effects of the operating cooling towers at Chalk Point showed no changes in soil chemical elements at distances of 1.6 to 9.6 km (1 to 6 miles) (Mulchi et al. 1982). In a study of five saltwater cooling towers near Galveston Bay, Texas, salt deposition up to 746 kg/ha/year was found within 100 m (328 ft) of the towers, with levels decreasing to <52 kg/ha (46 lb/acre) per year at 434 m (1424 ft) (Wiedenfeld et al. 1978). Weekly deposition ranged from 4.27 kg/ha (3.81 lb/acre) per week to 58.8 kg/ha (52.5 lb/acre) per week. In the survey, salt content of the soil at 104 m (341 ft) from the towers returned to previous levels when towers were shut down during the winter.

4.3.4.2 Plant-Specific Operational Data

Annual reports of environmental monitoring for vegetation damage at nuclear plants were reviewed. Vegetation monitoring included detailed measurements of vegetation structure and composition on permanent plots, aerial infrared photography with subsequent field surveys for vegetation injury, or general surveillance. Vegetation damage ranging from foliar chlorosis to defoliation can be identified on false-color infrared aerial photographs (NUREG/CR-1231). Vegetation monitoring for drift effects has been conducted at 18 nuclear plants. Most of the nuclear plants are not located close to agricultural areas, but six of the plants monitored crops, pasture, orchards, or ornamental vegetation. None reported visible damage to ornamental vegetation or reduction in crop yield (Table 4.3).

A detailed study at Palo Verde in Arizona showed that, after 6 years of operation, no change in agricultural soils attributable to cooling tower emissions occurred. Although significant increases or decreases occurred in some soil parameters at some monitoring locations, these changes appear unrelated to cooling-tower operation and were believed to have been caused by irrigation management, cropping, and fertilizer application. At the conclusion of the 6-year study, no significant effects on

Table 4.3 Results of nuclear facility monitoring for cooling-tower drift effects on terrestrial vegetation

Plant	Vegetation effects	Type of monitoring
	Natural draft	
Arkansas	No visible damage; no foliar chemical changes after one year	Aerial photography; foliar chemistry; orchard, native trees
Beaver Valley	No visible damage	Aerial photography; soil pH and conductivity; native vegetation
Byron	No visible damage	Aerial photography; crops; woody, ornamental, and native vegetation
Callaway	No visible damage	Aerial photography; permanent vegetation plots; native trees
Davis-Besse	No visible damage	Aerial photography; soil chemistry; native vegetation
Hope Creek	No visible damage after one year; no foliar chemical changes after one year	Ground survey; foliar chemistry; soil chemistry; native vegetation
Three Mile Island	No visible damage	Visual inspection; crops and native vegetation
Trojan	No visible damage	Aerial photography; pasture, ornamental and native vegetation
	Mechanical draft	
Catawba	Possible ice damage to loblolly pine < 61 m (200 ft) from towers	Aerial photography; ground survey; native trees
Duane Arnold	No visible damage	Visual inspection; native vegetation
Edwin I. Hatch	No visible damage	Aerial photography; permanent vegetation plots; native vegetation

Table 4.3 (continued)

Plant	Vegetation effects	Type of monitoring
Joseph Farley	No visible damage	Aerial photography; native vegetation
Palisades	Severe ice damage < 61 m (200 ft) from towers; some icing beyond 250 m (820 ft); sulfate injury < 150 m (492 ft) from towers; change in vegetation caused by damage to trees	Aerial photography; permanent vegetation plots; native vegetation
Palo Verde	No visible damage; foliar salt concentrations increased on site	Aerial photography; foliar chemistry; soil chemistry; crops and native vegetation
Prairie Island	Frequent ice damage to oaks adjacent to towers; change in canopy structure caused by ice damage; reduced viability in acorns from oaks near towers	Aerial photography; ground survey; acorn viability survey; native vegetation
River Bend	No visible damage	Aerial photography; permanent vegetation plots; native vegetation
Fort Saint Vrain	No visible damage	Aerial photography; crops; native vegetation
Washington	No foliar chemical changes	Foliar chemistry; soil chemistry; native vegetation

crops or native vegetation had been noted, and the study was discontinued (Halliburton NUS 1992).

At the Palisades plant in Michigan, concern was expressed by owners of nearby fruit orchards about possible effects of elevated humidity on the incidence of disease, particularly apple scab, in their orchards. The concern was that increased humidity could result in the need for increased applications of disease-control sprayings and thus increase orchard operating costs. NRC staff recommended a survey program to assess impacts of cooling-tower moisture on yield, quality, and frequency of disease-control sprayings (NRC 1978). Weather conditions encouraging apple scab are temperatures of 17 to 24°C (63 to 75°F) and

>85 percent relative humidity for 9 h or more. A study was conducted to determine these weather conditions near Palisades cooling towers and in more distant areas (Ryznar et al. 1980). Long-term weather records from weather stations outside the influence of the Palisades cooling towers were analyzed. In addition, a network of meteorological stations was established in the vicinity of the Palisades plant. No increase in weather occurrences favoring apple scab was observed that could be related to Palisades operation.

4.3.4.3 Conclusion

Monitoring results from the sample of nuclear plants and from the coal-fired Chalk Point plant, in conjunction with the literature review and information provided by the natural resource agencies and agricultural agencies in all states with nuclear power plants, have revealed no instances where cooling tower operation has resulted in measurable productivity losses in agricultural crops or measurable damage to ornamental vegetation. Because ongoing operational conditions of cooling towers would remain unchanged, it is expected that there would continue to be no measurable impacts on crops or ornamental vegetation as a result of license renewal. The impact of cooling towers on agricultural crops and ornamental vegetation will therefore be of small significance. Because there is no measurable impact, there is no need to consider mitigation. Cumulative impacts on crops and ornamental vegetation are not a consideration because deposition from cooling tower drift is a localized phenomenon and because of the distance between nuclear power plant sites and other facilities that may have large cooling towers. This is a Category 1 issue.

4.3.5 Terrestrial Ecology

This section addresses the impact of cooling tower drift on natural plant communities (Section 4.3.5.1) and the impact of bird mortality resulting from collisions with natural-draft cooling towers (Section 4.3.5.2).

4.3.5.1 Effects of Cooling-Tower Drift

This section addresses the extent to which natural plant communities near nuclear plants are affected by exposure to salts, icing, or other effects (e.g., fogging and increased humidity) caused by operation of cooling towers. The approach to evaluating this issue is the same as that used for evaluating the impact on agricultural crops in Section 4.3.4.

4.3.5.1.1 Overview of Impacts

The potential impacts of cooling tower operation on native vegetation are similar to those for agricultural crops, including salt-induced leaf damage, growth and seed yield reduction, and ice-induced damage (see Section 4.3.4). In addition, native vegetation may suffer changes in community structure (Talbot 1979) in response to ice damage or differences in species tolerances to drift. Increased fogging and relative humidity near cooling towers have little potential to affect native vegetation, and no such impacts have been reported.

The following standard of significance is applied to the effects of cooling tower operation on natural plant communities. The impact is of small significance if no measurable degradation (not including short-term, minor, and localized impacts) of natural plant communities results from cooling tower operation.

Species vary in their sensitivity to soil salinity and foliar salt deposition, and their tolerances of drift deposition are not well known. Curtis et al. (PPSP) determined that experimental exposure to saline cooling-tower drift for one growing season resulted in foliar damage to vegetation when leaf Cl^- levels were between 3145 and 9000 μg/g dry weight. These investigators also found that several species of trees growing under field conditions were not always as sensitive to salt deposition as they were under greenhouse conditions. Actual sensitivities of native trees may therefore be less than those shown in Table 4.2. Age of leaves also affects sensitivity to deposition. McCune et al. 1977 found that the youngest leaves of deciduous woody species and the year-old needles of conifers were more susceptible than leaves of other ages. Seasonal deposition, therefore, has the potential to affect these species groups differently. The most sensitive native species, flowering dogwood, shows injury from deposition above 1.2 kg/ha (1.1 lb/acre) per week, and the least sensitive species, witch hazel, shows injury above 1042.8 kg/ha (930.6 lb/acre) per week (Talbot 1979). Deposition rates near nuclear plant cooling towers, according to available deposition data, appear to be generally below the rate that would adversely affect dogwood.

Talbot (1979) reviewed studies of vegetation damage at nine industrial cooling tower installations. Three of the six installations having mechanical draft towers (one saltwater and two freshwater) produced some damage to native vegetation within 215 m (705 ft). Natural draft towers at three sites had no reported visible effects on vegetation. Natural draft cooling towers using brackish water at the coal-fired Chalk Point plant resulted in elevated chloride concentrations in vegetation after 1 year of tower operation (PPSP-CPCTP-18), but symptoms of salt toxicity in native trees had not been observed after 2 years of operation (Lauver et al. 1978), after which monitoring was terminated because of the absence of significant effects (C. L. Mulchi, University of Maryland, personal communication with H. Quarles, ORNL, Oak Ridge, Tennessee, March 15, 1995).

Impacts on native vegetation as a result of soil salinization (Section 4.3.4) are not expected except possibly in arid environments. Although according to McBrayer and Oakes (1982), the predicted annual salt deposition of 25 to 50 kg/ha (22 to 51 lb/acre) near the Palo Verde cooling towers could increase soil salinity enough to alter distribution of certain species because natural soil salinity is already close to their salt tolerances, a monitoring study conducted over the first 6 years of cooling tower operation showed no significant effects on native vegetation or crops (Halliburton NUS 1992).

4.3.5.1.2 Plant-Specific Operational Data

Vegetation monitoring at nuclear plants is described in Section 4.3.4. Of the 18 plants reviewed, visible vegetation damage resulting from cooling tower operation was reported for only the Catawba, Palisades, and Prairie Island plants, all with mechanical-draft towers (Table 4.3). At these facilities, damage has been reported primarily within 150 m of the towers. Although no vegetation damage was reported at Palo Verde, increased foliar salt concentrations were found on-site (Halliburton NUS 1992).

At the Catawba Plant a few loblolly pine trees adjacent to the cooling towers were apparently damaged by ice. Damage to the trees consisted of some browning of needles on trees nearest the towers.

At Palisades, monitoring conducted in response to observed vegetation damage included chloride and sulfate deposition and visual observation of damage. Vegetation damage resulted primarily from sulfate and was more extensive than at any other nuclear facility because, at Palisades' unique location, the tops of the cooling towers are lower than the tops of forested dunes on the site. This unique position of the cooling towers contributes to interception of cooling tower emissions by dune vegetation. Vegetation injury ranged from visible signs to severe necrosis of leaves to near-total defoliation in areas with maximum impact. In 1975, severe icing from drift interception also caused extensive damage by breaking branches as well as trunks of trees (Rochow 1978). Approximately 8 ha (20 acres) was affected by sulfates and icing, including about 6 ha (15 acres) of forest. Sulfate damage resulted from addition of sulfuric acid to the cooling water. However, this practice was discontinued, thus significantly reducing the impacts; and the severe icing in 1975 may have resulted from unusual weather conditions combined with a possible cooling tower malfunction (Ryznar et al. 1980).

Vegetation damage was found to correlate with elevated rates of sulfate deposition from the Palisades towers (Rochow 1978); chloride deposition, however, was less than 1.0 g/m^2/month in areas of extensive vegetation damage and did not correlate with the damage. Sulfate deposition rates were 0.61 g/m^2/month between 700 and 1609 m (2296 and 5278 ft) and 9.0 g/m^2/month within 50 m (164 ft) of the tower. About 75 percent of the sulfate fell out within 145 m (129 ft) of the towers (Rochow 1978). Heaviest damage to vegetation was in areas receiving more than 5 g/m^2/month sulfate, but areas receiving 2 to 5 g/m^2/month also were heavily damaged. Areas receiving 1 to 2 g/m^2/month were damaged primarily in the upper portions of trees.

Monitoring at Prairie Island included aerial photography, ground surveys of vegetation, and acorn viability monitoring. Viability of acorns collected from red oak trees located near the mechanical-draft towers was low, although acorn production appeared normal. Icing from plume downwash, which occurred frequently, may have damaged developing embryos in the acorns, which take 2 years to develop (Richardson 1976; Richardson 1978). Ice also damaged some of the trees growing adjacent to the towers. Because the towers at Prairie Island have not been used for cooling during the winter since 1984, icing damage has been eliminated.

Monitoring at Palo Verde included drift deposition, soil chemistry, salt concentrations in vegetation, and aerial photography. Drift deposition up to 95.6 kg/ha (85.3 lb/acre) per year has occurred on the site within 1.6 km (1 mile) of the cooling towers. Amounts of approximately 25 to 50 kg/ha (22 to 45 lb/acre) per year were predicted to alter soil salinity enough to affect vegetation over the long term (McBrayer and Oakes 1982). Increases in soil sodium, potassium, or chloride content have been reported, but increases also occurred in some sites that were distant from the towers (Halliburton NUS 1992). Observed changes in soil chemistry at Palo Verde appeared to be unrelated to cooling tower operation, and no effects on vegetation were reported.

4.3.5.1.3 Conclusion

Monitoring results from the sample of nuclear plants and from the Chalk Point plant, in conjunction with the literature review and information provided by the natural resource agency and agricultural agencies in all states with nuclear power plants, have revealed no instances where cooling tower operation has resulted in measurable degradation of the health of natural plant communities. Observed vegetation damage caused by icing and cooling-tower drift at mechanical draft towers usually is minor and localized in small ares (e.g., Catawba and Prairie Island). Damage to native vegetation has not occurred at Chalk Point coal plant and the Hope Creek nuclear plant, which use brackish water for cooling and represent a comparatively high probability of impact from operation of natural draft towers. Therefore, damage at other nuclear plants with natural draft towers is unlikely. Damage from operation of mechanical-draft towers at Palisades was more extensive than for the other nuclear plants, but was limited to about 8 ha (20 acres) on the site. The damage resulted from Palisades unique location, the addition of sulfuric acid to cooling water, and possibly from a cooling tower malfunction combined with unusual weather conditions. The use of sulfuric acid was discontinued, significantly reducing the impact. Cooling tower drift in the arid environment at Palo Verde has not affected native species through soil salinization: no actual damage was reported over a 6 year study of cooling tower operation (Halliburton NUS 1992). The only potential mitigation measures would be to change to another cooling system or to modify the cooling towers to reduce the amount of drift. Because the impacts of cooling tower drift on native plants are expected to be of small significance at all plants and because the potential mitigation measures would be costly, no mitigation measures beyond those implemented during the current term license would be warranted. Cumulative impacts on natural plant communities are not a consideration because of the distance between nuclear power plant sites and other facilities that may have large cooling towers. This is a Category 1 issue.

4.3.5.2 Bird Collisions with Cooling Towers

This section addresses the significance of avian mortality resulting from collisions of birds with natural-draft cooling towers at nuclear plants. Natural-draft towers, which are tall structures, cause some mortality, whereas mechanical-draft towers cause negligible mortality and are not addressed here. This issue was evaluated by reviewing the general literature for avian collision mortality associated with all types of man-made objects, as well as the monitoring studies conducted at six nuclear plants. The literature review is presented in Section 4.5.6.2. The significance of the mortality caused by cooling towers is determined by examining the actual numbers and species of birds killed and comparing this mortality with the total avian mortality resulting from other man-made objects and with the abundance of bird populations near the towers.

4.3.5.2.1 Overview of Impacts

Throughout the United States, millions of birds are killed annually when they collide with man-made objects, including radio and TV towers, windows, vehicles, smoke stacks, cooling towers, and numerous other objects. An overview of collision mortality for all types of man-made objects is included in the discussion of transmission lines in Section 4.5.6.2.

Avian mortality due to man-made structures is of concern if the stability of the local population of any bird species is threatened or if the reduction in the numbers within any bird population significantly impairs its function within the local ecosystem. Avian mortality resulting from collisions of birds with cooling towers is considered to be of small significance if the losses do not threaten the stability of local populations of any species and if there is no noticeable impairment of its function within the local ecosystem.

4.3.5.2.2 Plant-Specific Analysis

Monitoring of bird collisions has been done at several nuclear plants with natural draft cooling towers, including the Susquehanna plant near Berwick on the Susquehanna River in eastern Pennsylvania, the Davis-Besse plant on the shore of Lake Erie in north central Ohio, the Beaver Valley plant on the Ohio River in extreme western Pennsylvania, the Trojan Plant on the Columbia River in extreme northwestern Oregon, the Three Mile Island plant near Harrisburg in southeastern Pennsylvania, and the Arkansas Nuclear One plant on Dardanelle Lake in northwestern Arkansas. The following information was obtained from nuclear plant annual monitoring reports and from a few other sources, as cited.

At the Susquehanna plant, surveys were conducted on weekdays during spring and fall migration from 1978 through 1986. This plant's natural draft towers are 165 m (540 ft) tall and illuminated at the top with 480-V aircraft warning strobe lights. About 1500 dead birds (total for all survey years) of 63 species were found that had apparently collided with the cooling towers. Others were probably lost in the tower basin water during plant operation. Most of the birds were passerines (songbirds). Fewer collisions seemed to occur during plant operation, when cooling tower plumes and noise may have frightened birds away from the towers. From 1984 through 1986, eight dead bats were also found, including little brown myotis, red bat, and big brown bat.

At Davis-Besse, extensive surveys for dead birds were conducted from fall 1972 to fall 1979. Early morning surveys at the 152-m (499-ft-) tall cooling tower were made almost daily from mid-April to mid-June and from the first of September to late October. After the tower began operating in the fall of 1976, some dead birds were lost through the water outlets of the tower basin. A total of 1554 dead birds were found, an average of 196 per year. The dead birds included 1222 at the cooling tower, 222 around Unit 1 structures, and 110 at the meteorological tower. Most were night-migrating passerines, particularly warblers, vireos, and kinglets. Waterfowl that were abundant in nearby marshes and ponds suffered little collision mortality. Most collision mortalities at the cooling tower occurred during years when the cooling tower was not well illuminated (1974 to spring 1978). After completion of Unit 1 structures and the installation of many safety lights around the buildings in the fall of 1978, collision mortality was significantly reduced (average of 236 per year from 1974 through 1977, 135 in 1978, and 51 in 1979). Diffusion of light from these safety lights may illuminate the cooling tower in such a way that birds can see and avoid it. Lights at nuclear plants may not confuse birds to the extent sometimes caused by lights on radio or TV towers (Section 4.5.6.2). Lights illuminating the Pilgrim Nuclear Station in Massachusetts apparently were not a problem to migrating birds, which were monitored by radar. The orientation, flight speed, and altitude of these birds appeared unaffected by the lights, although on one of nine nights, flight direction at the station was different from that in a control area and flight altitude was higher (Marsden et al. 1980).

At Beaver Valley, surveys were conducted in spring and fall from 1974 through 1978 at the natural draft tower. A total of 27 dead birds were found. At the Trojan Plant, surveys were conducted weekly in 1984 and 1988 at the 152-m 499-ft-) tall cooling tower, meteorological tower, switch yard, and generation building. No dead birds were found. At the 113-m (371-ft-) tall cooling towers at Three Mile Island, a total of 66 dead birds were found from 1973 through 1975 (Temme and Jackson 1979). No dead birds were found at Arkansas Nuclear One, where monitoring at the natural-draft tower was done twice weekly from October 15 through April 15 in 1978–79 and 1979–80.

4.3.5.2.3 Conclusion

Existing data on cooling-tower collision mortality suggest that cooling towers cause only a very small fraction of the total bird collision mortality (see Section 4.5.6.2 for a review of this mortality). The relatively few nuclear plants having natural-draft towers in the United States (approximately 32 units), combined with the relatively low bird mortality at individual natural draft towers, shows that (1) these nuclear plant towers are not greatly affecting bird populations (see Section 4.5.6.2.1) and (2) their contribution to the cumulative effects of bird collision mortalities is very small. Mechanical-draft cooling towers, which are not nearly as tall as natural-draft towers, and other facilities pose little risk to migrating birds.

Local bird populations are apparently not being significantly affected by collision with cooling towers. Waterfowl and other birds that are commonly present as permanent or summer residents around nuclear plants do not frequently collide with the towers. Instead, a very high percentage of the collision mortalities occur during the spring and fall bird migration periods and involve primarily birds migrating at night. Studies that have been conducted at six nuclear plants, in conjunction with literature reporting total collision mortality (Section 4.5.6.2), show that (1) avian mortality associated with cooling towers is a very small part of the total mortality and (2) local bird populations are not being significantly reduced. Data on collision mortality were found for only 6 of the 20 nuclear plants with natural-draft cooling towers. Collision mortality at one or more of these plants may be greater than at the plants where surveys were conducted.

Avian mortality resulting from collisions of birds with cooling towers involves sufficiently small numbers for any species that it is unlikely that the losses would threaten the stability of local populations or result in a noticeable impairment of the function of a species within local ecosystems. There is no reason to believe that the annual mortality rate resulting from collision of birds with any cooling tower would be different during the license renewal term. Thus, avian mortality resulting from collision with cooling towers is of small significance. A potential method of mitigating avian morality would be to illuminate natural draft cooling towers at night. Because it is unlikely that the numbers of birds killed from collision with cooling towers are large enough to affect local population stability or impair the function of a species within the local ecosystem, consideration of further mitigation is not necessary. Because any contributions of cooling tower collisions to overall bird mortality have already been expressed in species populations, it is not expected that there will be any incremental or cumulative impact on bird populations from cooling tower collision mortality due to relicensing of current nuclear plants. The cumulative effect of bird mortality is further considered with transmission lines in Section 4.5.6.2. Avian mortality resulting from collision with cooling towers is a Category 1 issue.

4.3.6 Human Health

Some microorganisms associated with cooling towers and thermal discharges can have deleterious impacts on human health. Their presence can be enhanced by thermal additions. These microorganisms include the enteric pathogens *Salmonella* sp. and *Shigella* sp. as well as *Pseudomonas aeruginosa* and the thermophilic fungi (Appendix D). Tests for these pathogens are well established, and factors germane to their presence in aquatic environs are known and in some cases controllable. Other aquatic microorganisms normally present in surface waters have only recently been recognized as pathogenic for humans. Among these are Legionnaires' disease bacteria (*Legionella* sp.) and free-living amoebae of the genera *Naegleria* and *Acanthamoeba*, the causative agents of various, although rare, human infections. Factors affecting the distribution of *Legionella* sp. and pathogenic free-living amoebae are not well understood. Simple, rapid tests for their detection and procedures for their control are not yet available. The impacts of nuclear plant cooling towers and thermal discharges are considered of small significance if they do not enhance the presence of microorganisms that are detrimental to water and public health.

Potential adverse health effects on workers due to enhancement of microorganisms are an issue for steam-electric plants that use cooling towers. Potential adverse health effects on the public from thermally enhanced microorganisms is an issue for the nuclear plants that use cooling ponds, lakes, or canals and that discharge to small rivers. These plants are all combined in the category of small river (average flow less than 2830 m^3/s (100,000 ft^3/s) in Tables 5.18 and 5.19. These issues were evaluated by reviewing what is known about the organisms that are potentially enhanced by operation of the steam-electric plants.

Because of the reported cases of fatal *Naegleria* infections associated with cooling towers, the distribution of these two pathogens in the power plant environs was studied in some detail (Tyndall et al. 1983; see also Appendix D). In response to these various studies (Appendix D), many electric utilities require respiratory protection for workers when cleaning cooling towers and condensers. However, no Occupational Safety and Health Administration (OSHA) or other legal standards for exposure to microorganisms exist at present. Also, for worker protection, one plant with high concentrations of *Naegleria fowleri* in the circulating water successfully controlled the pathogen through chlorination before its yearly downtime operation (Tyndall et al. 1983).

Changes in the microbial population and in the use of bodies of water may occur after the operating license is issued and the application for license renewal is filed. Ancillary factors may also change, including average temperature of water resulting from climatic conditions. Finally, the long-term presence of a power plant may change the natural dynamics of harmful microorganisms within a body of water by raising the level of *N. fowleri*, which are indigenous to the soils. Increased populations of *N. fowleri* may have significant adverse impacts. On entry into the nasal passage of a susceptible individual, *N. fowleri* will penetrate the nasal mucosa. The ensuing infection results in a rapidly fatal form of encephalitis. Fortunately, humans in general are resistant to infection with *N. fowleri*. Hallenbeck and Brenniman (1989) have estimated individual annual risks for primary amebic meningoencephalitis caused by the free living *N. fowleri* to swimmers in fresh water, to be approximately 4×10^{-6}. Heavily used lakes and other fresh bodies of water may merit special attention and possibly routine monitoring for *N. fowleri*.

Thermophilic organisms may or may not be influenced by the operation of nuclear power plants. The issue is largely unstudied. However, NRC recognizes a potential health problem stemming from heated effluents. Occupational health questions are currently resolved using proven industrial hygiene principles to minimize worker exposures to these organisms in mists of cooling towers. NRC anticipates that all plants will continue to employ proven industrial hygiene principles so that adverse occupational health effects associated with microorganisms will be of small significance at all sites, and no mitigation measures beyond those implemented during the current term license would be warranted. Aside from continued application of accepted industrial hygiene procedures, no additional mitigation measures are expected to be warranted as a result of license renewal. This is a Category 1 issue.

Public health questions require additional consideration for the 25 plants using cooling ponds, lakes, canals, or small rivers (all under the small river category in Tables 5.18 and 5.19) because the operation of these plants may significantly enhance the presence of thermophilic organisms. The data for these sites are not now at hand and it is impossible to predict the level of thermophilic organism enhancement at any given site with current knowledge. Thus the impacts are not known and are site-specific. Therefore, the magnitude of the potential public health impacts associated with thermal enhancement of *N. fowleri* cannot be determined generically. This is a Category 2 issue.

4.3.7 Noise Impacts

When noise levels are below the levels that result in hearing loss, impacts have been judged primarily in terms of adverse public reactions to the noise. Generally, power plant sites do not result in off-site levels more than 10 dB(A) above background. However, some sites have calculated impacts to critical receptors at this level and above. Noise level increases larger than 10 dB(a) would be expected to lead to interference with outdoor speech communication, particularly in rural areas or low-population areas where the day-night background noise level is in the range of 45–55 dB(A). Generally, surveys around major sources of noise such as large highways and airports have found that, when the day-night level increases beyond 60 to 65 dB(A) (FICN 1992), noise complaints increase significantly. Noise levels below 60 to 65 dB(A) are considered to be of small significance.

The principal sources of noise from plant operations are natural-draft and mechanical-draft cooling towers, transformers, and loudspeakers. Other occasional noise sources may include auxiliary equipment such as pumps to supply cooling water from a remote reservoir. Generally, these noise sources are not perceived by a large number of people off-site.

In most cases, the sources of noise are sufficiently distant from critical receptors outside the plant boundaries that the noise is attenuated to nearly ambient levels and is scarcely noticeable. However, during the original license application process, some of the sites identified critical receptors near plant boundaries that would experience noise levels greater than 10 dB above ambient. Those levels would increase the difficulty in outdoor speech communication. (The noise would require that people speak louder to communicate.) In no case is the off-site noise level from a plant sufficient to cause hearing loss.

Natural-draft and mechanical-draft cooling towers emit noise of a broadband nature, whereas transformers emit noise of a specific tonal nature at harmonics of the 60-Hz primary frequency. The frequencies with important intensities are 120, 240, 360, and 480 Hz. Loudspeakers emit noise at audible frequencies, generally below 5000 Hz. Because of the broadband character of the cooling towers, the noise associated with them is largely indistinguishable and less obtrusive than transformer noise or loudspeaker noise. Transformer noise is distinct because of its specific low frequencies. These low frequencies are not attenuated with distance and intervening materials as much as higher frequencies are; thus, low frequencies are more noticeable and obtrusive. However, at most sites employing cooling towers, transformer noise is masked by the broadband cooling tower noise. Loudspeakers would be a more intermittent source of noise.

Cooling tower and transformer noises do not change appreciably with time. No change in noise levels or their attendant impacts would be expected during the license renewal term.

License renewal does not add to the extent of noise impacts, either in frequency distribution or in intensity. No major changes in the noise profile of power plants is anticipated. The only possible source of added impacts would be the result of additional people who build homes near enough to the site that they are affected by noise. At the noise levels anticipated, no cumulative biological impacts are expected.

During the license renewal term, noise impacts will be the same as during the initial license term. These impacts were found to be generally not noticed by the public, thus noise impacts are of small significance. Consideration was given to mitigating these noise impacts. Because the principal sources of noise are cooling towers, transformers, and loudspeakers, these sources would be the focus of noise reduction efforts. Reduction in loudspeaker noise could be accomplished by restricting such use to emergencies only and using personal electronic pagers to contact personnel. Mitigation of the low-frequency noise from cooling towers or transformers is much more difficult and would require shielding by massive concrete structures or earthen berms.

Because these noise reduction methods would be costly and given that there have been few complaints and the noise impacts are so small, no additional mitigation measures are warranted for license renewal. This is a Category 1 issue.

4.4 COOLING PONDS

4.4.1 Introduction

Power plants that use cooling ponds compose a unique subset of closed-cycle systems in that they operate as once-through power plants [i.e., large condenser flow rates (Table 2.1)] that withdraw from and discharge to relatively small bodies of water created for the plant. Cooling ponds reduce the heat load to natural bodies of water from power plant operations without the construction and operational expenses of cooling towers. The natural body of water is not relied on for heat dissipation but is used as a source of makeup water to replace that lost to evaporation and as a receiving stream for discharges from the cooling pond.

4.4.1.1 Types of Cooling Ponds

The range of power plants that use cooling ponds or lakes represents a gradation from closed-cycle power plants sited on small cooling ponds to once-through power plants sited on large, multipurpose reservoirs. For the purpose of this section, a cooling pond will be defined as "a man-made impoundment that does not impede the flow of a navigable system and that is used primarily to remove waste heat from condenser water prior to recirculating the water back to the main condenser" (ORNL/NUREG/TM-226). Under this definition, nine nuclear power plants use cooling ponds: Braidwood, Clinton, Dresden, La Salle, H. B. Robinson, South Texas, Virgil C. Summer, Wolf Creek, and Turkey Point (actually an extensive system of canals for recirculating water). Effects of other power plants located on large, multipurpose reservoirs (e.g., Comanche Peak and William B. McGuire) are included in the analysis of once-through cooling systems in Section 4.2.

The surface areas of the cooling ponds associated with these nine plants range from 629 to 2924 ha (1573 to 7310 acres). Braidwood, Clinton, Dresden, La Salle, and South Texas all use large cooling ponds that rely on nearby rivers for makeup water. Both H. B. Robinson and Clinton recycle their heated effluent in cooling ponds that are impoundments of relatively small creeks. The Virgil C. Summer plant dissipates waste heat to Monticello Reservoir, which in turn receives makeup water from Parr Reservoir. Wolf Creek recycles its condenser cooling water through a cooling pond that receives its makeup water from nearby John Redmond Reservoir. Turkey Point recirculates condenser cooling water through a complex series of canals.

4.4.1.2 Cooling Pond Emissions and Effluents

Power plants sited on cooling ponds do not have unique effluents or emissions. The examples considered in this section represent open-cycle condenser cooling systems that use the man-made pond to recirculate cooling water. Discharges to natural waters are used primarily to control the buildup of dissolved solids, analogous to blowdown from cooling towers, and may or may not have elevated temperatures. The types of emissions and effluents are the same as those considered for once-through cooling systems in Section 4.2.

Also, intake and discharge effects are regulated in the same way as for once-through cooling systems [i.e., through NPDES permits and, if needed, CWA Section 316(a) and (b) determinations (see Section 4.2 for a discussion of these regulatory mechanisms)].

Accelerated evaporation of water from a cooling pond produced by thermal loading from the power plant increases the concentration of total dissolved solids (TDS). Concentrations of TDS in cooling reservoirs average about 1.8 times those in the makeup waters (ORNL/NUREG/TM-226). Contaminants may also accumulate in the pond water and sediments. Accumulation of such water quality constituents as metals (copper or zinc) and chlorinated organic compounds in water, sediments, and aquatic biota has been cited as a potential issue for power plants located on cooling ponds.

4.4.2 Surface Water Use and Quality

This section and Section 4.4.4 review the past and ongoing impacts on aquatic resources of operation of nuclear power plants with cooling ponds. Any ongoing impacts will probably continue into the license renewal term because the cooling system design and operation are not expected to change. Judgments about the significance of these issues during the license renewal term are based on published information, agency consultation, and information provided by the utilities (Appendix F) applicable to every nuclear power plant in the United States. The conclusions reached in these sections apply to all nuclear power plants with cooling ponds.

4.4.2.1 Water Use

Nine nuclear power plants use off-stream ponds or lakes as cooling devices. Although these off-stream bodies of water were specifically designed to serve as cooling systems for temperature reduction before discharge into a river or reservoir, some (e.g., La Salle County Nuclear Station) provide recreational fishing opportunities in addition to cooling. The water-use issue associated with operation of cooling ponds is the availability of adequate streamflows to provide makeup water, particularly during droughts or in the context of increasing in-stream and off-stream uses. Two nuclear power plants, the Braidwood Station and the Wolf Creek Generating Station, have already experienced water-use conflicts.

Braidwood, which withdraws makeup water for its cooling pond from the Kankakee River, will face future water availability conflicts as Joliet, Illinois, becomes a potential downstream water user. Potential use of water upstream for irrigation may also affect the Kankakee River flow and the availability of water for the Braidwood facility. In response to other water-use demands, Braidwood, La Salle County, Dresden, and other nuclear facilities using cooling ponds or lakes, particularly those on the same river system as other thermoelectric generating facilities, may have to reevaluate their overall water requirements and tolerances to drought conditions. For example, Braidwood was forced to cease withdrawal from the Kankakee River during much of July and August 1988 because the flow of the river was below the level at which makeup withdrawals were permitted [Commonwealth Edison Company response to NUMARC survey (NUMARC 1990); Gary Clark, telephone interview with V. R.

Tolbert, ORNL, Oak Ridge, Tennessee, July 5, 1990]. These plants could increase the sizes of their cooling ponds or adopt other measures to compensate for an inability to withdraw makeup water during low flows or because of competing water uses (Gary Clark, Illinois Division of Water Resources, personal communication to V. R. Tolbert, ORNL, Oak Ridge, Tennessee, July 5, 1990).

Probably the most important change in the consideration of water-use impacts since the initial licensing of most of the nuclear generating facilities has been the increased emphasis on in-stream flow for preservation of aquatic habitat, riparian (streamside) habitat, and associated biota. An example of potential water-use conflicts is associated with the withdrawal of makeup water by the Wolf Creek Generating Station in Kansas. Water for the Wolf Creek cooling lake is withdrawn from the Neosho River downstream of John Redmond Reservoir. Riffle (shallow water) areas of this river serve as habitat for a threatened fish species, the Neosho madtom. Makeup water withdrawals during severe drought conditions could affect the riffle habitat of this species (Harold Spiker, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, June 28, 1990).

Nuclear power plants that withdraw makeup water for cooling ponds from small bodies of water may need to curtail operations during drought periods or may experience future conflicts with other water users (including increasing emphasis on in-stream uses). This potential issue affects only a small number of existing plants, and mechanisms exist for resolving these conflicts (e.g., through derating the plant during temporary drought periods or, if longer-term solutions are required, by the periodic renewals of the plants' NPDES permits). Consultations with regulatory agencies indicate that water use conflicts are already a concern at two of the nine nuclear power plants with cooling ponds (Braidwood and Wolf Creek). Because water use conflicts may be of small or moderate significance during the license renewal period, this is a Category 2 issue for nuclear plants with cooling systems that utilize cooling ponds. The effects of consumptive water use on in-stream and riparian communities could also be of small or moderate significance, depending on the plant, and also are a Category 2 issue.

4.4.2.2 Water Quality

An issue associated with the operation of a cooling pond is potential alteration of the quality of both pond and natural receiving waters as a result of the addition and concentration of a variety of chemicals. As with all other types of condenser cooling systems, chemicals (e.g., chlorine) may be added to control biofouling and to inhibit scaling and corrosion in the condenser tubing. In addition, corrosion products are leached into the circulating water flow and may be concentrated in the recirculating system.

Discharges of heat and chemical contaminants are controlled by the NPDES permits that are issued and periodically renewed for each power plant (Section 4.2). Whereas the volume of water that is discharged to a natural body of water from a cooling pond may be comparable to that discharged as blowdown from a cooling tower, the concentration of dissolved solids is less. In ORNL/NUREG/TM-226, Parkhurst and McLain estimate that the average concentration of TDS is about 400 percent above ambient in the blowdown from cooling towers and about 180 percent above ambient in the discharge from cooling reservoirs. Greater quantities of biocides may also be needed for cooling towers than for cooling ponds because of the additional need to control biofouling on the cooling tower surfaces.

Larimore and McNurney (EPRI EA-1148) compared the water quality of a power plant cooling lake (Lake Sangchris in Illinois) with that of a nearby lake unaffected by power plant discharges. The most obvious differences resulted from the heat input and power-plant-induced circulation, which prevented seasonal thermal stratification in the cooling lake. With the exception of temperature, no water quality differences between the two lakes were attributed to power plant operations.

Becker et al. (EPRI EA-1054) examined available data from 14 cooling impoundments (all associated with fossil-fuel power plants) to identify water quality and ecological effects. These 14 cooling impoundments were selected from a population of 135 steam-electric power plant cooling ponds across the United States as those most likely to provide "worst-case" conditions for identifying impacts from power plant operation. Selection was based on load ratio, that is, impoundment surface area divided by rated plant generating capacity in megawatt (electrical). The authors assumed that cooling impoundments with low load ratios (relatively little dilution of power plant discharges) would be most likely to exhibit discharge-related water quality and ecosystem effects. Neither low DO concentration nor supersaturation of other dissolved gases was a problem, although oxygen deficits occurred in deeper waters of those cooling ponds that stratified.

There was no indication that plant chlorination increased the chloride concentration of closed impoundments. Evaporation from a completely closed pond (no blowdown) resulted in gradual, long-term concentration of inorganic constituents, but levels did not exceed those commonly tolerated by aquatic life.

Potentially more important than the overall increase in TDS is the concentration of specific constituents—for example, heavy metals. The accumulation of heavy metals in cooling ponds via evaporation and bioconcentration has not been identified as a concern by the utilities or regulatory agencies, although specific studies appear to be uncommon. In a survey of 14 cooling impoundments, Becker et al. (EPRI EA-1054) found data on metals for only one. Trace metal concentrations were measured at North Lake, a cooling impoundment in Texas with one of the lowest load ratios in the study. North Lake is a completely enclosed system with essentially no drainage. As a result of high evaporative water losses, water levels cannot be maintained solely by precipitation, so makeup water must be pumped from the nearby Trinity River. In 15 years of operation, the cooling impoundment was refilled about 5.5 times, a situation that should lead to relatively high concentrations of water quality constituents. The North Lake data indicated that trace metals (copper, chromium, iron, lead, manganese, and zinc) were not accumulating in the impoundment, and the levels were too low to be toxic to the ecosystem (Sams 1976). On the other hand, a study of copper concentrations at eight nuclear power plants indicated that the highest chronically elevated concentrations in the discharge waters occurred at the H. B. Robinson Steam Electric Plant Unit 2, a plant with a

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cooling impoundment (ASTM STP 854). Examination of a variety of factors, including influent water quality and copper specification, led Harrison (ASTM STP 854) to conclude that elevated levels of copper in the H. B. Robinson plant effluent could be attributed to the low-pH water in the region, which caused relatively high leaching of copper from the condenser tubes. The naturally high corrosivity of the water appeared to be the cause of elevated copper concentrations at this plant. The copper-containing tubing was subsequently replaced because of high leakage, eliminating copper loading to the cooling pond [Carolina Power & Light Company response to NUMARC survey (NUMARC 1990)].

Although power plant chlorination may result in the presence of chlorinated organic compounds, the potential accumulation of these materials appears to have been studied rarely. Sams (1976) investigated the possible buildup of total chlorinated organic compounds in the closed cooling impoundment of a fossil-fueled power plant but detected no quantitative differences between the pond and its makeup water source.

The Illinois Department of Conservation has expressed concern about the adverse influence of discharges from the Dresden Nuclear Power Station cooling pond on the temperature and water quality of the Kankakee River (Mark Frech, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, July 2, 1990). EPA has also pointed out that Dresden may have difficulty meeting temperature limits in the future as water quality improves and standards become more stringent (Robert Springer, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, June 29, 1990). With this exception, the effect of operation on water quality is not a concern at the nine nuclear power plants that use cooling ponds as part of their condenser cooling systems. In all cases, the NPDES permits and 316(a) determinations that limit the discharge of heat and other pollutants are periodically reevaluated and renewed by the EPA or state water quality permitting agencies, allowing existing or future water quality issues to be resolved in a timely manner.

The impacts of condenser cooling system discharges on water quality of cooling ponds are considered to be of small significance if water quality criteria (e.g., as contained in NPDES permits) are not violated and if aquatic organisms in the vicinity of the plant are not bioaccumulating metals or other contaminants. Based on review of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft GEIS, degradation of water quality in cooling ponds has not been a problem at most existing nuclear power plants. Mitigation was effective at the one plant that experienced elevated metal levels during the current license period. Effects are considered to be of small significance for all plants. Heat is rapidly dissipated in the vicinity of the power plant so that far-field, cumulative effects would not be expected. No evidence of existing, significant accumulation of contaminants in or near cooling ponds was found in the literature or provided by regulatory agencies. No change in operation of the cooling system is expected during the license renewal term, so no change in effects of discharges on water quality of cooling ponds is anticipated. Effects of discharges to cooling ponds could be reduced by operating additional water treatment systems, greater flushing of the cooling pond/reservoir, or by reducing the plant's generation rate. However, because the effects of discharges on water quality of cooling ponds are considered to be impacts of small significance and because these changes would be costly, the staff does not consider the implementation of these potential mitigation measures to be warranted. Effects of condenser cooling water discharges on water quality of cooling ponds are a Category 1 issue.

4.4.3 Aquatic Ecology

As noted in Section 4.4.2, the concentrations of TDS in cooling ponds averages less than three times that in the makeup water. Such concentrations of most water quality constituents are unlikely to affect aquatic biota. However, elevated levels of particular constituents may be of greater concern. For example, formerly elevated copper concentrations in the effluent from the H. B. Robinson plant (Section 4.4.2) were implicated in increased deformities and reduced reproductive capacity in the bluegill population residing in the cooling pond (NUREG/CR-2822; ASTM STP 854). Harrison and Lam (NUREG/CR-2822) concluded that these sublethal effects were the result of leaching of copper from the condenser tubes by the low-pH water in the pond. Although the highest concentrations of copper in fish tissue were found in bluegills collected in the discharge area, tissue concentrations were also elevated in the intake site compared with an upstream control site. Following replacement of the copper-alloy condenser tubing, fish populations recovered and skeletal deformities disappeared [Carolina Power & Light Company response to NUMARC survey (NUMARC 1990)].

In addition to potential effects from water quality degradation, aquatic biota of cooling ponds may be affected by impingement, entrainment, and thermal discharges. These effects are the same as those considered for once-through cooling systems (Section 4.2.2), except that they mainly influence aquatic communities that did not exist before creation of the cooling pond; natural communities are affected to a lesser extent by the relatively small withdrawals and discharges associated with makeup water and blowdown. In a review of impacts of cooling impoundments of fossil-fuel power plants, Becker et al. (EPRI EA-1054) detected no major detrimental impacts on fish populations from power plant operation. The qualitative effects observed included earlier seasonal spawning and faster growth rates, which the authors attributed to elevated water temperatures. Information was not adequate to determine quantitative power plant effects on fish populations in the 14 impoundments studied. Larimore and McNurney (EPRI EA-1148) compared fish populations of a cooling lake and a nearby noncooling lake. Largemouth bass in the cooling lake spawned earlier, grew faster, were more accessible to anglers in the winter, and had lower rates of parasitic infestation. Parkhurst and McLain (ORNL/NUREG/TM-226) reviewed effects of cooling reservoirs on fish populations. They concluded that (1) effects on game fish populations are generally insignificant or positive but rarely negative, (2) growth rates are generally similar to those of fish from other waters, (3) some species may spawn earlier in the heated environment, (4) many species are attracted to the heated areas during the winter and avoid those areas in the summer, and (5) the thermal tolerances of species inhabiting heated waters are often higher than those for the same species inhabiting ambient-temperature waters.

Consultations with regulatory agencies and nuclear utilities that operate cooling ponds have revealed some site-specific concerns. For example, the Virgil C. Summer Nuclear Station has experienced thermal-discharge-effect-related fish kills in recent summers in and around the heated water discharge bay (James A. Timmerman, Jr., letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, July 2, 1990). These fish kills were localized; they do not appear to have had any adverse effect on the cooling pond population. The utility is investigating the specific causes of the fish kills to implement corrective actions [South Carolina Electric & Gas Company response to NUMARC survey (NUMARC 1990)]. Concerns about biological effects of inadequate in-stream flows below the Wolf Creek Generating Station, particularly during drought years, have been raised (Harold L. Spiker, letter to G. F. Cada, ORNL, Oak Ridge, Tennessee, June 28, 1990). This water-use issue is discussed in Section 4.4.2.1.

The operating experience of nuclear power plants using cooling ponds indicates that impacts on aquatic resources appear to be a function of unique characteristics of the plant or the environment and not generally the result of the cooling system technology. Water-use conflicts (Braidwood, Wolf Creek) and hot weather fish kills (Virgil Summer) could occasionally develop at many fossil-fuel and nuclear power plants. Elevated concentrations of trace metals, which should be most apparent in recirculating cooling ponds, were a concern at only one plant. In this example, elevated copper concentrations in the effluent are believed to have resulted from the leaching of copper from condenser tubing by naturally acidic water; the extent to which buildup of copper in the pond by the recirculation of cooling water also contributed to the subsequent biological effects was not determined. Because effects on the bluegill population have been eliminated by the replacement of the condenser tubing with noncopper alloys, recirculation of residual copper in the cooling pond does not appear to be a problem.

Water quality and aquatic ecology issues for nuclear power plants that use cooling ponds, are summarized in Table 4.4. As noted for power plants with once-through cooling systems in Section 4.2.3.2, operational experience indicates that most early aquatic resource concerns have been found to be of small significance at all sites, and no mitigation measures beyond those implemented during the current term license would be warranted. For the reasons given in Section 4.2.2, these are Category 1 issues. However, entrainment and impingement of fish and thermal discharge effects are of sufficient concern on large cooling ponds that support valued aquatic resources that they continue to be examined in detail as part of CWA Section 316(a) and (b) demonstrations. Section 316(a) or (b) determinations are pending for two of the nine nuclear power plants with cooling ponds (Braidwood and Clinton). Further, changes in aquatic communities of either the cooling ponds or source bodies of water could warrant reexamination of entrainment, impingement, or heat shock effects at any of the plants before the time of license renewal. For some plants, the large volumes of water withdrawn, heated, and discharged back to the receiving water may cause adverse effects to fish populations during the license renewal term. Because impacts of fish entrainment and

Table 4.4 Significance of aquatic resources impacts for license renewal of existing nuclear power plants that use cooling ponds

Issue	Impact significance[a]
Water quality, hydrology, and use	
Water-use conflicts	2
Altered current patterns at intake and discharge structures	1
Altered salinity gradients	1
Temperature effects on sediment transport capacity	1
Altered thermal stratification of lakes	1
Scouring due to discharged cooling water	1
Eutrophication	1
Discharge of chlorine or other biocides	1
Discharge of metals in waste water	1
Discharge of sanitary wastes and minor chemical spills	1
Effects of consumptive water use and riparian communities	2
Aquatic ecology	
Impingement of fish	2
Entrainment of fish, early life stages	2
Entrainment of phytoplankton and zooplankton	1
Thermal discharge effects	2
Cold shock	1
Thermal plume barrier to migrating fish	1
Distribution of aquatic organisms	1
Premature emergence of aquatic insects	1
Stimulation of nuisance organisms (e.g., shipworms)	1
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	1
Gas supersaturation (gas bubble disease)	1
Low dissolved oxygen in the discharge	1
Accumulation of contaminants in sediments or biota	1

[a]A 1 means that the impact is expected to be of small significance at all sites. A 2 means that the impact may be of moderate or large significance at some sites.

impingement and of thermal discharge effects could be small, moderate, or large, depending on the plant, these are Category 2 issues for nuclear plants that use cooling ponds.

4.4.4 Terrestrial Ecology

The issue evaluated in this section is the extent to which vegetation and wildlife are affected by increased fogging, humidity, and icing near cooling ponds and by water contaminants that may be present in the ponds. The primary impacts of cooling ponds on terrestrial ecological resources occurred when the ponds were constructed and filled, resulting in flooding and loss of terrestrial plant and animal communities. Potential impacts during plant operation include exposure of terrestrial habitats near the ponds to increased levels of humidity, icing, and fog. Also, waterfowl and other wildlife that use the ponds may be exposed to increased levels of dissolved solids and other contaminants released from the power plant. Fogging, humidity, icing, and the presence of dissolved solids and other contaminants that might be present in or at cooling ponds are of concern if they are present at levels that threaten the stability of local wildlife populations or vegetation communities in the vicinity of the cooling ponds. If there is no threat to the stability of local wildlife populations or vegetation communities, then any impact is considered of small significance.

These potential impacts apparently have not been a problem at any plant with cooling ponds. No significant damage to or loss of vegetation has been reported to result from increased humidity, fog, or icing. Without damage to vegetation, wildlife populations should not be affected. Water quality in the ponds is not being degraded to the extent that aquatic life is adversely affected (Sections 4.4.2 and 4.4.4). Therefore, wildlife using these ponds should not be significantly affected by changes in water quality or by loss of aquatic food or prey. Bioaccumulation of contaminants in the bodies of wildlife predators feeding on aquatic biota is not expected to be a problem because of the very low concentrations of contaminants. Because no threat to the stability of local wildlife populations or vegetation communities is found for any cooling pond, the impacts are found to be of small significance. Potential mitigation measures would include excluding wildlife (e.g., birds) from contaminated ponds, converting to a dry cooling system, or reducing plant output during fogging or icing conditions, the impacts are found to be so minor that consideration of additional mitigation measures is not warranted. These effects of cooling ponds are so minor and so localized that cumulative impacts are not a concern. This is a Category 1 issue.

4.5 TRANSMISSION LINES

Impacts of transmission lines result from their maintenance, electromagnetic fields, corona, and rights-of-way (ROW). Their impacts on air quality (Section 4.5.2), land use (Section 4.5.3), human health (Section 4.5.4), surface water quality and aquatic ecology (Section 4.5.5), terrestrial ecology (Section 4.5.6), floodplains and wetlands (Section 4.5.7), and historic and aesthetic resources (Section 4.5.8) are assessed in this section. As at the construction permit stage, the transmission corridor of concern is that which was constructed between the plant switchyard to its connection with the existing transmission system. No new transmission line construction is planned in existing or new corridors. The types of impacts of transmission lines during the license renewal period will be the same as those during the first 40 years of operation.

4.5.1 Introduction

Transmission lines use voltages of about 115 or 138 kV and higher. In contrast, local or area distribution lines use voltages below 115 or 138 kV. Only transmission lines are discussed in this document. Extra-high-voltage transmission lines operate at 345 to 800 kV, whereas ultra-high-voltage (UHV) lines operate at 1000 kV and above. Lines up to 765 kV, a voltage occurring primarily in the eastern United States, are in commercial operation, whereas UHV lines are still in the testing stage of development. The principal advantage of higher-voltage lines is that they can transmit proportionately more power than can lower-voltage lines.

Detailed descriptions of transmission lines and basic electrical concepts are provided by ORNL-6165, DOE/BP-945, and BNWL-1774. Typical transmission line structures, shown in Figure 4.1, range in height from about 20 to 52 m (65 to 170 ft) and provide average spans (the distance between structures) of about 106 to 350 m (350 to 1150 ft). The structures support a three-phase system of conductors and two ground wires above the conductors. The ground wires intercept lightning strikes to prevent the strikes from hitting the conductors and adversely affecting power system operation. The most common structure types are the H-frame and lattice; single-pole and guyed-Y types are less common. The H-frame is usually made of wood and is used for lower-voltage lines. The metal lattice structure is capable of bearing more weight than the H-frame, allowing greater span length, higher-voltage lines, and more circuits for a given width of ROW.

Transmission lines must be inspected periodically to detect any deterioration of or damage to line components. This inspection can be done from the ground but is often done from a helicopter. Maintenance or repairs of power lines may require that vehicles gain access to the lines.

Electric and magnetic fields, collectively referred to as electromagnetic field or EMF, are produced by operating transmission lines. EMF strength at ground level varies greatly under these lines, generally being stronger for higher-voltage lines, a flat configuration of conductors (as opposed to, for example, the delta configuration), relatively flat terrain, terrain with no shielding obstructions (e.g., trees or shrubs), and a closer approach of the lines to the ground. At locations where field strength is maximum, measured values under 500-kV lines often average about 4 kV/m, but sometimes exceed 6 kV/m. Maximum electric field strengths at ground level are 9 kV/m for 500-kV lines and 12 kV/m for 765-kV lines (DOE/BP-945).

Measured magnetic field strengths at the location of maximum values beneath 500-kV lines often average about 70 mG (milligauss). During peak electricity use, when line current is high, the field strength may peak at 140 mG (about 1 percent or less of the time) (DOE/BP-945).

The term "corona" generally refers to the electrical discharges occurring in air subjected to the strong electric fields adjacent to phase conductors. Corona generally is not a problem at voltages below 345 kV. Corona results in audible noise, radio and TV interference, energy losses, and the production of ozone and oxides of nitrogen.

An ROW must be acquired by the utility to prevent certain land uses and vegetation growth from interfering with transmission line operation. To ensure power system reliability, the growth of tall vegetation under the lines must be prevented (by cutting or herbicides) to avoid physical interference with lines or the potential for

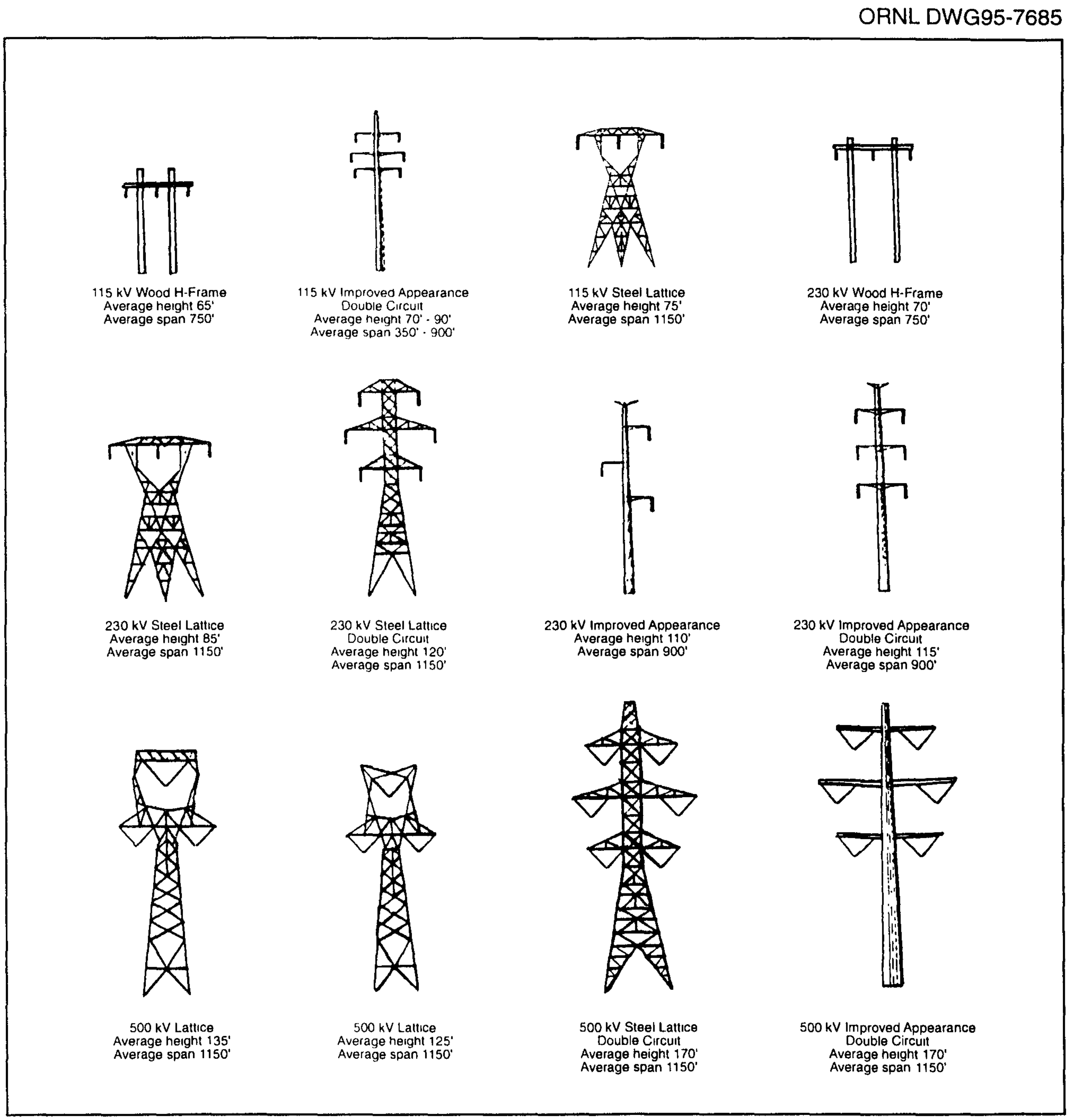

Figure 4.1 Examples of typical transmission line towers. *Source:* DOE/BP-945.

short-circuiting from the line to the vegetation. At the edge of ROW, trees that could topple onto the lines must be removed.

ROW maintenance is described in greater detail by FWS/OBS-79/22, ORNL-6165, BNWL-1774, and Byrnes and Holt (1987).

4.5.2 Air Quality

Small amounts of ozone and substantially smaller amounts of oxides of nitrogen are produced by transmission lines during corona, a phenomenon that occurs when air ionizes near isolated irregularities on the conductor surface such as abrasions, dust particles, raindrops, and insects. Several studies have quantified the amount of ozone generated and concluded that the amount produced by even the largest lines in operation (765 kV) is insignificant (SNYPSC 1978; Scott-Walton et al. 1979; Janes 1980; Varfalvy et al. 1985). Monitoring of ozone levels for 2 years near a Bonneville Power Administration 1200-kV prototype line revealed no increase in ambient ozone levels caused by the line (Bracken and Gabriel 1981; DOE/BP-945). Ozone concentrations generated by transmission lines are therefore too low to cause any significant effects. The minute amounts of oxides of nitrogen produced are similarly insignificant. A finding of small significance is supported by the evidence that production of ozone and oxides of nitrogen are insignificant and does not measurably contribute to ambient levels of those gases. Potential mitigation measures (e.g., burying transmission lines) would be very costly and would not be warranted. This is a Category 1 issue.

4.5.3 Land Use

4.5.3.1 Overview of Impacts

The concerns addressed by this section involve the extent to which license renewal and up to an additional 20 years of plant operation will preclude alternative uses of the transmission line corridor and the relative value that should be placed on such alternative uses. At the time of a license renewal application the transmission corridor and lines will have been in place for well over 20 years, having been initially constructed to furnish power to the site for construction of the plant. Even after cessation of plant operation the transmission line to the site would continue to be used to bring power in to the site during decommissioning. It is likely that a utility would locate new generating capacity on a site and utilize the existing transmission corridor. The site and transmission corridor are valuable assets for the utility. Therefore, the most likely scenario is that regardless of whether a license is renewed it should be anticipated that a transmission corridor will continue in use for the transmission of power indefinitely.

The issue addressed by this section is the extent to which existing transmission lines will, after relicensing, continue to preclude productive use of land or interfere with land uses (e.g., cultivation). Impacts are expected to be no different from those that have occurred during past power line operation. Impacts are described and assessed by reviewing the published literature reporting monitoring data on this topic. No monitoring data on land-use impacts were found that deal with transmission lines specifically associated with nuclear plants. However, because transmission lines associated with nuclear plants are no different from lines associated with other types of generating facilities, literature on any type of transmission line is applicable to the analysis in this section.

The impact of transmission lines on land use resulting from license renewal is considered of small significance if there is no increase in the amount of land committed to the corridor right-of-way and if there are no major changes in the use patterns of the corridor resulting from renewal of the operating license. Alterations in the corridor path could result in impacts of moderate to large significance. Relocating the transmission corridor could result in large land use impacts. There is no basis to believe that any alteration in a transmission corridor would be made in conjunction with license renewal.

The presence of a transmission line and its ROW precludes certain land uses on the ROW that could bring economic gain to the landowner and decreases the profits of forestry, agricultural, orchard, and vineyard operations. However, the landowner has been compensated to some extent for these economic losses by the initial purchase of the ROW easement or, in some cases, by purchase of the land itself.

The construction of buildings or any other permanent structures that could interfere with transmission line operation is usually prohibited on a power line ROW. In contrast, several land uses can occur on ROW without endangering line operation and are usually not restricted by the ROW easement, including hiking, hunting, off-road vehicle use, grazing, agricultural cultivation, irrigation, and roads. Power-line corridors on private property may sometimes increase the frequency of trespassing.

In rural areas, the primary impact on land use is continuing interference with agricultural cultivation, orchards, vineyards, spraying, and irrigation. Some mobile irrigation facilities are very long and may cover an entire field or a large part of the field in one operation (Varner and Patel 1984). The presence of a transmission line structure in such a field may require that the irrigation facility be segmented into two or more independent pieces. Such segmentation increases the labor requirements and the costs of the irrigation facility. Aerial spraying of an agricultural field is restricted by transmission lines; spraying costs may be increased, and the extra maneuvers that the aircraft pilot must make to avoid the lines may lessen the effectiveness of the pesticide coverage.

Impacts on crop production that may have been caused by transmission line interference with aerial spraying have been reported by one field study of cotton, rice, and soybean fields crossed by a 500-kV line in eastern Arkansas (Parsch and Norman 1986). This study hypothesized that crop yields could be reduced either by EMFs (see Section 4.5.6.3) or by inadequate aerial spraying directly under the power lines. Only cotton yields were found to be reduced: 15 percent less lint was produced under the lines than 150 ft from the lines. The resulting loss of income from cotton was estimated as $85.25 per year for an 1100-ft (335-m) span of the lines, based on a 15 percent yield reduction and an average lint yield of 480 lb/acre. The field sampling and statistical analyses were extensive; the observed yield reduction appeared to be real rather than a sampling error. However, the study could not determine whether the EMF or line interference with aerial spraying caused the yield reduction.

The presence of a transmission line structure in any agricultural field, irrigated or not, will continue to exclude land from production and increase the time and money required to perform weed control, cultivation, and harvesting. The major (e.g., 70–90 percent) economic cost results from the exclusion of otherwise productive land from cultivation. The amount of land area affected depends on the structure type and size, the type of crop, and the agricultural practices involved (Grumstrup et al. 1982; EPRI WS-78-141). For lattice-type structures 8 to 9.8 m^2 (26 to 32 ft^2) at the base, the exclusion of productive land varies from about 488 to 976 m^2 (1600 to 3200 ft^2) for each structure. Operations for cultivating some types of crops can be conducted beneath structure bases if the structure is large enough, thus minimizing losses. The presence of guy wires significantly increases the area of land excluded from production, while non-guyed single-pole and H-frame structures have about half as much impact as lattice structures (Grumstrup et al. 1982). Minor additional costs result from the maneuvering necessary for farm machinery to avoid tower legs. Lattice structures and guyed structures interfere more with farming practices than do pole-type structures.

Costs also depend on the relative locations of transmission line structures within fields (Table 4.5). A study of corn, soybean, wheat, oats, buckwheat, and hay fields in Ontario found that the amount of land excluded from production increased in the following order of structure locations: (1) straddling a fence row (minimal impact); (2) adjacent to a fence row; (3) adjoining the headland (the end of the field where the tractor turns) but in the main part of the field; (4) midfield; and (5) within the headland, near, but not adjacent to, a fence row (maximum impact) (EPRI WS-78-141). In tobacco fields, equipment operations differed from those in grain fields, and structures in midfield obstructed cultivation on about twice as much land area as did structures in the headland (Scott 1982). For a variety of grain crops, the economic losses caused by power lines were accounted for by the following factors: time lost—about 30 percent of the costs; land excluded from production—about 60 percent; damaged crop costs—about 2 percent; and material loss—about 8 percent (EPRI WS-78-141). In vineyards, orchards, and tobacco fields, about 75 to 95 percent of the total costs resulted from the continuing exclusion of land from production (EPRI WS-78-141; Scott 1982). In general, the economic losses associated with transmission line structures are closely related to the value of the affected crop, and the percentage of total economic loss resulting from land lost to cultivation is proportionately higher for higher value crops (Scott 1982). Tobacco, orchard, and vineyard crops have relatively high value per acre; grain crops have lower value.

Utilities sometimes locate transmission lines in agricultural areas rather than wooded areas to minimize maintenance costs. Although utilities pay a higher price for ROW on agricultural land, overall costs are minimized by avoiding the higher long-term costs of ROW vegetation maintenance that would be necessary in wooded areas (EPRI WS-78-141).

The potential impact of transmission lines on land use differs among nuclear plants in different geographic regions because land

Table 4.5 Estimated losses in crop profits caused by a lattice structure[a]

Crop	Structure location	
	Midfield	Headland
Tobacco	$356	$132
Peach orchard[b]	95	84
Vineyard[b]	117	53
Wheat	15	—
Soybeans	18	—
Grain corn	25	—
Silage corn	30	—

[a]The currency is the Canadian dollar 1977–1980. The structure is 8.5 × 8.5 m (28 by 28 ft) at the base and its orientation is square to the crop rows as opposed to diagonal to crop rows.
[b]The midfield value is based on not being able to drive equipment under structures and is an average of several midfield variations of structure positioning.
Sources: EPRI WS-78-141; Scott.

uses (e.g., different types of agricultural crops) are different in different regions. The type and extent of the impacts of power lines on land use are relatively well known, and no monitoring of land-use impacts has been done for any specific nuclear plant.

4.5.3.2 Conclusion

There is no basis to believe that the renewal of any operating license will change existing land use in the transmission line corridor either in terms of the amount of land committed or activities taking place within or adjacent to the corridor. For this reason, the staff finds that the impacts of transmission lines on land use attributable to license renewal is of small significance. Ongoing land use impacts would be expected to continue, e.g., constraints on agricultural activity. Although transmission line towers prevent some land from being cultivated or grazed, the amount of land area involved represents only a very small fraction of existing cropland and pasture in the vicinity of transmission lines. Therefore, the reduction in total harvest or livestock production typically has no significant impact on individual farm production or on overall production in larger regions such as townships or counties. The interference with aerial spraying caused by transmission lines can affect an area that is larger than that of the tower site, but the yield in this larger area would not be expected to be reduced by more than a small fraction (e.g., a 15 percent yield reduction in cotton).

The presence of transmission lines does not cause additional permanent loss of farmland (in the sense that farmland is lost, for example, to parking lots and buildings during urban development). Any restrictions on land use within the corridor right-of-way would have been imposed and compensated for as necessary years earlier.

Additional mitigation might require removal of wires, towers, and tower bases so that the entire area previously occupied by towers could be used for farming. Because such mitigation would be costly and would provide little environmental benefit, further consideration of mitigation is not warranted. The significance of any impacts is so minor and localized that cumulative impacts are not an issue. This is a Category 1 issue.

4.5.4 Human Health

The two human health issues related to transmission lines are the acute effect, shock hazard, and the potential for chronic effects from exposure to electric and magnetic fields. As stated previously, the transmission line of concern is that between the plant switchyard and the intertie to the transmission system. Transmission lines are necessary to transfer energy from all types of electrical generating facilities to consumers. Therefore, these issues are generic to the 118 nuclear power plants. Issues are evaluated by referral to the National Electric Safety Code [NESC (1981)] for the shock hazard issue and a review of relevant literature for the issue of potential chronic effects from exposure to the electric and magnetic fields surrounding transmission lines.

EMFs resulting from 60-Hz power transmission lines fall under the category of nonionizing radiation. An example of ionizing radiation is the X-ray. Much of the general population has been exposed to power line fields since near the turn of the century. However, except for the concern about electrical shock from insulated conductors such as fences, there was little concern about health effects from such exposures until the 1960s. A series of events during the 1960s and 1970s heightened public interest in the possibility of non–shock-related health effects from nonionizing radiation exposures and resulted in increased scientific investigation in this area (Wilson et al. 1990). Then, in 1979, results of an epidemiological study suggested a correlation between proximity to high-current wiring configurations and incidence of childhood leukemia (Wertheimer and Leeper 1979). This report resulted in additional interest and scientific research; however, no consistent evidence linking harmful effects with 60-Hz exposures has been presented.

4.5.4.1 Acute Effects (Shock Hazard)

Primary shock currents are produced mainly through direct contact with conductors and have effects ranging from a mild tingling sensation to death by electrocution. Tower designs preclude direct public access to the conductors. Secondary shock currents are produced when humans make contact with (1) capacitively charged bodies such as a vehicle parked near a transmission line or (2) magnetically linked metallic structures such as fences near transmission lines. A person who contacts such an object could receive a shock and experience a painful sensation at the point of contact. The intensity of the shock depends on the EMF strength, the size of the object, and how well the object and the person are insulated from ground.

Design criteria that limit hazards from steady state currents are based on the NESC (1981), adherence to which requires that utility companies design transmission lines so that the short-circuit current to ground, produced from the largest anticipated vehicle or object, is limited to less than 5 mA. In practice, this limits the electric field near roadways to about 7–8 kV/m. No similar code exists for the limitation of the magnetic fields of transmission lines; however, because of concerns about the safety of magnetic fields, several states have created their own regulations. See Nair et al. (1989) for a review of these regulations.)

With respect to shock safety issues and license renewal, three points must be made. First, in the licensing process for the earlier licensed nuclear plants, the issue of electrical shock safety was not addressed. Second, some plants that received operating licenses with a stated transmission line voltage may have chosen to upgrade the line voltage for reasons of efficiency, possibly without reanalysis of induction effects. Third, since the initial NEPA review for those utilities that evaluated potential shock situations under the provision of the NESC, land use may have changed, resulting in the need for a reevaluation of this issue.

The electrical shock issue, which is generic to all types of electrical generating stations, including nuclear plants, is of small significance for transmission lines that are operated in adherence with the NESC. Without review of each nuclear plant transmission line conformance with NESC criteria, it is not possible to determine the significance of the electrical shock potential. This is a Category 2 issue.

4.5.4.2 Chronic Effects

4.5.4.2.1 Results of Ongoing Research

Substantial scientific evidence from laboratory studies funded primarily by DOE and EPRI indicates that extremely low-frequency (ELF) electric and magnetic fields can, under certain conditions, cause biological effects (Wilson et al. 1990; Polk and Postow 1986; Adey and Lawrence 1984; Chiabrera et al. 1985; EPA/600/6-90/005A; Carpenter and Ayraptyan 1994). The importance of these effects for humans who are exposed to transmission line fields is not clear. Perhaps the greatest deficiency in understanding at this time is the lack of a mechanistic theory capable of predicting biological effects from low-level EMF exposures (EPA/600/6-90/005A). Without an understanding of how these EMF fields are interacting with biological functions, the knowledge gained from scientific studies is of limited value both in evaluating the importance of the study results and in devising rational protection strategies for the public and for utility workers.

At exposure levels capable of producing relatively high current densities (10 to 100 mA/m^2), a substantial body of evidence has been accumulated indicating that EMF fields may influence biological function (IRPA/INIRC 1990). Such exposures have been suggested to induce chromosome aberrations, alter the distribution in molecular weights during protein synthesis, inhibit production of melatonin, alter calcium binding in brain tissue, influence RNA transcription, and produce a variety of other effects (OTA-BPA-53 1989). Questions concerning the potential carcinogenic effects of EMF field exposure have been raised as a result of suggestive epidemiological findings and some laboratory experiments. Two currently accepted models of cancer are the initiation-promotion paradigm (Easterly 1981; Stevens et al. 1990). Currently, most investigators conclude that EMF fields are not likely to act as initiators because they have not been shown to cause genetic damage (Aldrich and Easterly 1987). EMF effects on RNA transcription, however, could imply increased reduction of oncogene products, and some investigators consider such data to be indicative of genetic effects (Goodman et al. 1983; Goodman et al. 1987; Goodman and Henderson 1986, 1988). Work is in progress on an attempt to replicate the studies suggesting modification of transcription by EMF. However, attempts thus far have been unsuccessful. Moreover, it has not been shown that EMF fields are cancer promoters, but the presence of some reported EMF bioeffects reveals the need for further study of this issue (Byus et al. 1987; Cain et al. 1986).

The EMF epidemiologic literature has been reviewed extensively (Aldrich and Easterly 1987; Ahlbom; Coleman and Beral 1988; EPA/600/6-90/005A; NRPB 1992). The strongest evidence of an association between certain forms of cancer and exposure to magnetic fields comes from the studies of childhood cancers, namely leukemia, cancer of the central nervous system (CNS), and lymphoma.[1] Several studies have found somewhat elevated, statistically significant risks and elevated nonsignificant risks for these three site-specific cancers in children for whom magnetic fields either have been estimated by the types of wires near their homes or have been measured at 2 mG (0.2 μT) or more. However, there are contradictory results within these same studies, and dose-response relationships could not be substantiated, except in Savitz et al. (1988), based upon limited information on wiring codes. [Savitz and Kaune (1993) have offered an improved analysis of this work.] Furthermore, little information exists on personal exposure and length of residency in the EMFs. Additional but weaker evidence of an association between leukemia, cancer of the CNS, and perhaps cancer of other sites comes from the occupational studies of EMF exposure.

The studies of residential adult exposures to EMFs also provide mixed evidence of a risk of leukemia, mainly because of lack of power or low exposure to levels of EMFs that are hypothesized as being associated with cancer. For the same reasons, these studies cannot be used as support for denying that such an association exists. However, the case control study of cancer in Colorado residents (Wertheimer and Leeper 1982) does support an association with CNS cancer and lymphoma if proximity to high-current electrical wiring configurations is assumed to be an adequate surrogate for exposure.

A careful review of the epidemiological studies involving leukemia, lymphoma, and cancer of the CNS shows a pattern of response that suggests, but does not prove the possibility of, a causal link. Evidence from a large number of biological test systems shows that these fields induce some biological responses in laboratory settings. However, the explanation of which biological processes are involved and the way in which these processes could causally relate to each other and to the induction of malignant tumors is not understood.

4.5.4.2.2 Transmission Line Exposures Relative to Domestic Exposures

An important question regarding regulations is whether transmission line exposures contribute significantly to total EMF field exposures. In most cases, fields produced inside the home by appliances and electrical wiring exceed contributions from transmission line fields. Exceptions to this rule are individuals living adjacent to high-voltage transmission line ROW. Also relevant is the fact that exposures to transmission line fields are considered more continuous than those to appliance fields because transmission line fields permeate large areas (e.g., an entire home). Fields generated by appliances are generally more localized, resulting in intermittent exposures as individuals move around and as the appliances are turned on and off.

Some comparisons (of induced currents) among transmission line exposures, domestic exposures, and exposures used in bioeffects experiments can be made using induced current density as an exposure metric. According to data provided in OTA-BPA-53, field strengths on the ROW of a 500-kV line induce body currents that are higher than those induced by domestic exposures produced by typical electrical appliances. Comparison with bioeffects experiments (OTA-BPA-53) shows that while current densities in many bioeffects experiments are higher than those typically induced by household exposures, some are significantly less. These comparisons are based, however, on average current densities predicted in humans, because EMF dosimetry has not advanced to the point of determining specific current densities in various tissues and organs. Nor has mechanistic understanding identified what field characteristics are important biologically.

4.5.4.2.3 Conclusion

Potential chronic effects are unquantified at this time. Subsequent to the 1992 National Energy Policy Act, a sequence of events relative to ELF research took place. The National Institute of Environmental Health Sciences (NIEHS) was made responsible for directing the EMF biological research funded through the Department of Energy. To oversee policy and general direction of this research, a National EMF Advisory Committee was assembled. Both the EPA and the National Institute for Occupational Safety and Health now maintain EMF hotlines, yet NIEHS has taken the position that the NIEHS has the sole responsibility for declaring whether a hazard exists and the magnitude of that hazard. Federal regulations are not anticipated in the near future, but some states have developed and other states are in the process of developing pertinent ambient field levels at ROW boundaries.

A careful review of the biological and physical studies of 60-Hz EMFs has failed at this time to uncover consistent evidence linking harmful effects with field exposures. EMF fields are unlike other agents that have a toxic effect (e.g., toxic chemicals and ionizing radiation) in that dramatic acute effects cannot be forced and longer-term effects, if real, are subtle. Nonetheless, a wide range of biological responses have been reported to be affected by EMF fields.

Even if clear adverse effects were apparent in the epidemiology literature or with some biological assay, considerable additional work would be required to determine how and what to mitigate, because evidence suggests that some EMF bioeffects do not follow the typical "more intensity is worse" relationship. Furthermore, there may be a subtle relationship between the intensity of the local geomagnetic field and the appearance of effects for some intensities of 60-Hz fields. This complicating evidence points to the fact that, while much experimental and epidemiological evidence has been accrued, the pieces still do not fit together very well.

Because of inconclusive scientific evidence, the chronic effects of EMF could not be categorized as either a Category 1 or 2 issue. NRC will continue to monitor the research initiatives, those within the national EMF program and others internationally, to evaluate the potential carcinogenicity of EMF fields as well as other progress in the EMF study disciplines. If NRC finds that a consensus has been reached by appropriate federal health agencies that there are adverse health effects, all license renewal applicants will have to address the health effects in the license renewal process.

4.5.5 Surface Water Quality and Aquatic Ecology

A basic concern with right-of-way and service road maintenance is the effect that such maintenance activities may have on the health of nearby aquatic ecosystems. The effects are considered of small significance if there is no measurable change in species diversity, abundance or health within the aquatic ecosystem. An effect of moderate significance is defined as one resulting in reduced abundance or health of one or several species that may eventually lead to the demise of the species. An effect of large significance is defined as one resulting in the loss of any species on which a high recreational or commercial value is placed or the collapse of the existing ecosystem.

Potential effects of transmission lines on aquatic resources would arise mainly from water quality impacts associated with maintaining power line ROW and service roads. Where roads cross or border on surface waters, soil erosion could cause elevated turbidity and sedimentation. Appropriate control techniques (e.g., grassed or wooded buffer strips between the road and the body of water) will minimize impacts. Because ROW are normally maintained by mowing or selective application of herbicides (Section 4.5.1.4), soil erosion from power line corridors should not normally be a problem. Potential toxic effects of herbicides that are applied to power line ROW and subsequently transported to surface waters should be considered in the maintenance program. By using herbicides approved for ROW use in accordance with FIFRA, significant adverse effects of herbicides are avoided. Mowing and other activities needed to maintain transmission line corridors are readily controllable to minimize impacts to aquatic resources. These activities are not expected to change during the license renewal term.

Changes in any affected aquatic ecosystem due to construction and maintenance practices will have taken place long before consideration of license renewal. Ongoing management practices with respect to controlling soil erosion and the proper application of herbicides will continue over the term of a renewed license. The aquatic ecosystem is expected to be unaffected by license renewal with no measurable change in species diversity, abundance or health. The effect of transmission lines on surface water quality and aquatic ecology is then of small significance. The continued use of proper management practices with respect to soil erosion and application of herbicides is expected. Impacts of any transmission lines on aquatic ecosystems over a larger geographic area or over time will be stable and not cumulative. The effect of transmission line right-of-way maintenance on surface water quality and aquatic ecology is a Category 1 issue.

4.5.6 Terrestrial Ecology

This section evaluates the impacts of ROW management on wildlife (Section 4.5.6.1); the impacts of bird collisions with transmission lines (Section 4.5.6.2); and the impacts of EMFs on plants, wildlife, and livestock (Section 4.5.6.3).

4.5.6.1 Impacts of ROW Management on Wildlife

The extent to which wildlife populations are affected by vegetation control on transmission line ROW is the issue evaluated by this section. The effects of ROW management in the transmission corridor during the license renewal term are considered of small significance if habitat diversity remains the same as that of the surrounding area, or is increased, while species population declines (if any) in the surrounding habitat are small. The significance of the impact is evaluated by a review of the voluminous published literature on this topic. Numerous scientific papers published mainly during the late 1970s and the 1980s were reviewed for this analysis. Data are not available for lines associated specifically with nuclear plants, but the literature applies to such lines because the same methods for ROW management are used for transmission lines associated with any type of generating facility. This issue was addressed by NRC environmental impact statements for the construction permit stage and the operating license stage.

Most data on the impacts of power line corridors on wildlife are for relatively moist areas of the United States where vegetation growth is rapid and vegetation must be controlled to prevent its interference with the transmission lines. In arid regions, little or no vegetation control is required, and the potential effects on wildlife are small. Potential effects are also small where lines cross croplands, because no vegetation management is required. The following discussion is therefore applicable primarily to forested regions where the utility must conduct vegetation control on transmission line ROW.

Broadcast spraying of herbicides and mowing of the entire corridor have greater periodic impacts on wildlife than do selective cutting or selective application of herbicides. Mowing reduces the vegetation on the ROW to a low stubble, and the remaining vegetation or the regrowth the first year after cutting provides little food or cover for wildlife. As a result of the reduced vegetation, populations of the primary species of birds that nest on a transmission line ROW have been shown to be reduced. Mammal populations may also be reduced, although few data have been collected to show such an impact. Resprouting and regrowth of vegetation on the ROW is usually rapid after cutting. If the vegetation is cut only once every 4 years rather than annually, it usually develops into a dense mixed growth of shrubs, shrub patches, saplings, forbs, and grasses. Bird populations increase along with the vegetation until the next mowing, when the cycle begins again (de Waal Malefyt 1984; Everett et al. 1981; Kroodsma 1982).

Broadcast spraying of herbicides is also done on a periodic basis and causes a cyclic effect on wildlife. However, spraying often kills entire plants, and resprouting is less common. Therefore, after a number of spraying cycles, some plant species are greatly reduced in abundance on the ROW. The resulting plant community consists of herbicide-resistant species and is often not very diverse. Grasses, ferns, and relatively few species of shrubs are usually the dominant vegetation. Correspondingly, the wildlife community has relatively few species and low population densities, and bird-nesting success in grass and forb areas on ROW has been observed to be low. Therefore, from the wildlife perspective, broadcast spraying is usually considered the least desirable vegetation maintenance technique. Annual mowing could have an effect similar to broadcast spraying but is seldom if ever used as a routine management technique for transmission line ROW (Cavanagh et al. 1976; Chasko and Gates 1981, 1982; de Waal Malefyt 1984; Hartley et al. 1984). Broadcast spraying of herbicides on some ROW that currently is mowed may become necessary if woody vegetation becomes too dense, as in ROW through mesophytic forests where forest regeneration is rapid (Luken et al. 1991).

Selective cutting or spraying of vegetation has less impact on wildlife because low-growing shrubs and other vegetation are left undisturbed and provide good wildlife habitat. Selective techniques are labor-intensive and thus may be more expensive than broadcast spraying or mowing. A primary goal of these selective techniques is to eliminate undesirable plant species from the ROW while keeping those that provide good wildlife habitat and that will not interfere with the power lines. Cutting and spraying are often combined because cut stems must often be sprayed to prevent resprouting and thus eliminate the plant. As the desirable plant species begin to dominate the ROW, they gain a competitive advantage and help to prevent the reestablishment of undesirable plants; thus, the long-term vegetation maintenance costs may be reduced (FWS/OBS-79/22, Luken et al. 1994).

Herbicides are generally not highly toxic to wildlife when they are properly applied for ROW management. Therefore, toxic effects of herbicides on wildlife are generally of little concern to wildlife biologists or wildlife managers. Of the many papers reviewed for this analysis, none expressed serious concern for toxic effects.[2] Rather, herbicide effects on wildlife have been shown to result from the vegetation changes that occurred as a result of herbicide application.[3] Changes in vegetation on an ROW or in any other habitat always cause changes in the wildlife community, whether the vegetation is cut or modified by herbicides. As in the case of cutting, herbicide effects on vegetation are usually beneficial to some wildlife species and detrimental to others. The literature referenced above shows that, as long as a diverse plant community remains on herbicide-treated ROW, a diverse wildlife community will also be present.

The maintenance of ROW vegetation as a low-growing plant community results in an ROW wildlife community that is characteristic of such vegetation. This wildlife community has some species of small mammals and birds that are not present in the natural plant communities bounding the ROW. Therefore, the presence of the ROW vegetation adds to the number of wildlife species found in the area. In addition, the ROW provides food and cover for many species of animals that were already present before line construction.[4] Forest edge along the ROW as well as along other open areas may provide some benefit to wildlife, but benefits of such an edge appear to have been overrated (Chasko and Gates 1982; Kroodsma 1984a, 1984b, 1987; Reese and Ratti 1988; Small and Hunter 1989).

The presence of the transmission line and its cleared corridor is apparently not a great disturbance to any wildlife species. Based on all of the literature reviewed, no wildlife species is known to have disappeared from habitats adjoining the corridors after line construction. Some species, however, are less abundant in the forest near the corridor than in the deeper forest, indicating avoidance of the transmission lines and/or the corridor (Kroodsma 1984b, 1984c). Because these species also appear to avoid other types of clearings (e.g., croplands or pasture), the openness of the corridor appears to be the feature being avoided, not the line itself. Predation on eggs and nestlings of forest birds has been observed to be greater near the forest/corridor edge than in the deeper forest and may be one factor responsible for some species appearing to avoid or to be less dense near the corridor (Chasko and Gates 1981, 1982).

The overall effect on wildlife of a transmission line corridor located within a forest appears to be an increase in the number of species present in the total corridor and forest area, while some populations of forest species are slightly lower as a result of the corresponding decrease in amount of forest habitat. Some bird and mammal species that inhabit grassy or brushy habitats are added to the area and are responsible for the increase in the number of species. At the same time, all other forest species remain in the area, and some find improved cover or food resources in the ROW. Population declines in forest species are usually small because the ROW is narrow and occupies only a small fraction of a forested area.

A current concern among ornithologists is the high degree to which forested habitats are being fragmented into smaller and smaller areas as a result of clearing for agriculture and urbanization. This fragmentation appears to be at least partly responsible for significant declines in the populations of many migrant bird species (Small and Hunter 1988; Yahner and Scott 1988). Transmission line corridors, probably because of their narrowness, have not been noted as a significant factor in forest fragmentation impacts on birds.

Where corridors cross particularly important wildlife habitats, impacts may be of greater concern. Impacts on winter habitats of certain big game animals were a particular concern. However, impact studies done for deer wintering yards in the northeastern United States and southeastern Canada (Jackson 1980; Willey and Marion 1980; Doucet et al., 1983, 1987), deer in winter habitats in the Northwest (Loft and Menke 1984), and elk winter habitats in the West (Nelson 1986) showed no significant impact.

Although animal population density is cyclic in response to vegetation changes in ROW, over the long term (i.e., over many cycles) the populations appear relatively stable, with no species being significantly affected. The overall impact of transmission line corridors, based on an extensive literature, appears to be neither significantly adverse nor significantly beneficial. The consensus among wildlife biologists appears to be that cleared transmission line corridors and their maintenance do not have significant adverse impacts and that corridors provide valuable wildlife habitats if properly managed. Of the papers reviewed for this GEIS, none was found that identified any impact of transmission line corridors on wildlife that was of great concern to the authors. The evidence supports a conclusion that continued ROW management during the license renewal term will not lower habitat diversity or cause significant changes in species populations in the surrounding habitat. Thus the impacts are of small significance. The only potential mitigation measure would be relocation of the transmission lines to less sensitive areas, but this would not be warranted due to the small benefit and high capital cost of such actions. No mitigation measures beyond those implemented during the current term license would be warranted and little potential for cumulative impacts is indicated. This is a Category 1 issue.

4.5.6.2 Avian Mortality Resulting from Collisions With Transmission Lines

Numerous studies have been published of avian mortality resulting from collisions with transmission lines and other man-made objects. The issue is whether collision mortality is large enough to cause long-term reductions in bird populations. The analysis of this issue is based on published literature addressing bird collisions with all types of man-made objects and applies to all transmission lines regardless of the type of generating facility. Monitoring data collected at one nuclear plant, Prairie Island, are also summarized.

Avian mortality resulting from collisions with transmission lines is of concern if stability of local populations of any bird species is threatened or if the reduction in the numbers within any bird population significantly impairs its function within the ecosystem. Avian mortality resulting from collisions of birds with transmission lines is considered to be of small significance if there is no threat to the stability of local populations of any species and if there is no noticeable impairment of its functioning within the local ecosystem.

Many millions of birds die each year from natural causes, and millions are killed each year in the United States as a result of colliding with windows of houses and other buildings, radio and TV towers, vehicles, transmission and distribution lines, telephone lines, cooling towers, smokestacks, and many other man-made objects. Numerous papers have reported the more noticeable, sometimes spectacular, kills that have occurred at radio and TV towers and at transmission lines located near lakes or wetlands where birds are concentrated.[5] Large bird kills at radio and TV towers occur at night during spring and fall bird migration and involve primarily passerine birds (songbirds) that appear to be confused by tower lights (Crawford 1981; Larkin 1988; Maehr et al. 1983; Taylor and Kershner 1986). These lights, during conditions of low clouds or fog, create a surrounding area of diffuse light that flying birds are reluctant to leave, with the result that the birds fly in circles around the towers. Thus, these birds run a high risk of colliding with the towers' guy wires. In contrast, kills along transmission lines involve a greater fraction of heavier, less agile birds such as waterfowl and cranes. Inclement weather is often a contributing factor in transmission line kills; lights are not a contributing factor, because they generally are not used to mark transmission lines.

It is unknown to what extent avian populations decline as a result of collision mortality of all types or mortality associated specifically with transmission lines. Several authors have concluded that the mortality caused by transmission lines in their studies did not cause a significant reduction in the bird populations located in their study areas. However, some of these authors expressed concern for cumulative impacts (Beaulaurier et al. 1984; Faanes

1987; Meyer and Lee 1981). Cumulative impacts would accrue as migratory birds such as waterfowl migrate to different areas and are exposed to additional lines, whereupon more collisions occur and total mortality continues to increase.

A few authors have also pointed out that bird mortality along the many thousands of miles of transmission and communication lines in the United States is probably of greater significance than the more noticeable kills in certain transmission line locations where birds are concentrated (Avery 1981; Willard and Willard 1978). The amount of bird mortality in nonwetland areas or in areas of average bird numbers has received little study because the individual bird kills are spread out over long distances and are hard to find. Therefore, accurate estimates of the total bird mortality caused by transmission lines do not exist, and the significance of transmission line collision mortality with regard to long-term population effects cannot be accurately assessed.

Overall, relatively little concern about bird collision mortality has been expressed in the literature. Generally, collision mortality has appeared to be only a small fraction of total mortality and therefore has not been considered to have significant population impacts. Banks (1979) estimated that human activity and bird collisions with man-made structures resulted in the deaths of about 196 million birds per year or 1.9 percent of the total bird mortality (about 10 billion per year) in the continental United States. About 63 million of the estimated 10 billion annual bird deaths (i.e., 0.63 percent) resulted from collision with all types of man-made structures. The transmission line impact would be a fraction of this estimate. Stout and Cornwell (1976) reported on waterfowl mortality. They estimated that about 0.07 percent of the nonhunting waterfowl mortality resulted from collisions with lines, including transmission, distribution, and telephone lines. These estimates, which are essentially all that is available in the literature, suggest that transmission lines do not pose a serious threat to avian populations. Banks (1979) states that most of the human-related mortality is accounted for by relatively few species and that these species maintain large, harvestable populations. This, as Banks pointed out, suggests that human activities do not significantly affect most bird species. Banks concluded that "activities of man that do not necessarily result in the death of birds but rather reduce reproductive potential, such as habitat alteration and environmental contamination, are much more likely to have long-term effects on avian populations."

More recent literature on bird collision mortality has not raised strong concerns that the Banks (1979) and Stout and Cornwell (1976) estimates are too low. However, Avery (1981) pointed out that collision mortality may be significantly higher than Banks' estimate of 63 million. He states that the primary source of collision mortality appears to involve the millions of miles of transmission and communication lines and the billions of glass windows throughout the country. He cites collision mortality estimates higher than Banks' estimates (e.g., 80 million bird deaths annually from collision with windows), but a lack of information prevented him from estimating mortality resulting from collisions with transmission lines. No study reviewed for this GEIS has suggested that collision mortality is a significant factor in reducing the populations of common bird species.

Several reports have suggested that rare species sometimes could be significantly affected by transmission and communication lines, particularly if the lines passed through an area where such species were concentrated (Faanes 1987; ORAU-142, 1978c; Meyer and Lee 1981; Willard and Willard 1978). For example, A. J. Crivelli et al. (1988) surveyed Dalmatian pelican mortality resulting from collision with a line through a pelican wintering area. They concluded that this mortality would result in a 1.3 to 3.5 percent reduction in the number of pelican breeding pairs in Greece and Bulgaria. Whooping cranes, an endangered species in the United States, have collided with power lines on at least 10 occasions according to Faanes (1987). The principal known cause of death for wild fledged whooping cranes is collision with power lines (Morkill and Anderson 1991). Several papers reviewed by Kroodsma (ORAU-142, 1978b) reported that 10 percent of the known mortality of bald eagles from 1960 to 1972 apparently resulted from collisions with some object, frequently a transmission line. Willard and Willard (1978) reported that 4 out of 200 nesting female white pelicans in a small Oregon population died from collisions with transmission lines and considered this mortality to be a significant impact on a small, threatened population.

Several studies have reported on relatively large collision kills where transmission lines crossed wetland areas being used by large concentrations of birds (Anderson 1978; Beaulaurier et al. 1984; Faanes 1987; ORAU-142, 1978c; Malcolm 1982; Meyer and Lee 1981; Rusz et al. 1986). Although the authors were concerned about the mortality, most of them reported that the data indicated the mortality was a small fraction of the number of birds present and that the local bird population was not significantly affected. The case reported by Malcolm (1982) appears to involve the greatest collision mortality.

Two additional studies reported collision-caused deaths of sandhill and whooping cranes, two species that appear particularly susceptible to collision with transmission lines. In the San Luis Valley, Colorado, 78 sandhill cranes and 3 whooping cranes collided with lines during the fall and spring in 1983 and 1984, as reported by W. M. Brown et al. (1985). Whooping cranes were the most frequent casualty in proportion to their abundance (13 to 29 birds observed at various times). These authors also reported that at least eight other whooping cranes in the Rocky Mountain population struck transmission lines from 1977 to 1985. In Idaho, in an area where nine pairs of sandhill cranes were observed nesting, three sandhill cranes and one whooping crane collided with lines during the first year after line construction (Howard et al. 1985).

Sandhill crane mortality in general from 1978 through 1985 was reviewed by Windingstad (1988). Known mortality was as follows: toxins (e.g., from moldy corn and waste peanuts)— approximately 5550 cranes; hail storm (1 occurrence)—600; avian botulism—150; avian cholera— 125; lightning (1 occurrence)—90; collision with transmission lines—5 occurrences reported, the worst resulting in 51 carcasses at a line crossing the Platte River near a crane roost site (numbers in the other four occurrences were not reported); unknown cause—8; lead poisoning—4, avian tuberculosis—1; and predators—1. Despite this extensive mortality in sandhill cranes, their midcontinent population has increased dramatically during the past few decades.

Modification of existing transmission lines has been investigated to reduce collision mortality in localities where relatively large kills occur. The most promising modifications include removal of the ground wires in the most critical locations or placing markers on the ground wires to make them more visible to birds. Such markers include black-and-white ribbons, orange aviation marker balls, plastic spirals, and spiral vibration dampers (Alonso et al. 1994; Brown et al. 1985; Faanes 1987; Morkill and Anderson 1991; ORAU-142, 1978d). For example, Alonso et al. found that colored PVC spirals installed on groundwires reduced bird collisions by 60 percent, and Morkill and Anderson found that yellow aviation balls installed on groundwires reduced sandhill crane collisions by 56 percent.

No relatively high collision mortality is known to occur along transmission lines associated with nuclear power plants in the United States other than the Prairie Island plant in Minnesota. This plant is located on the Mississippi River southeast of Minneapolis and may be the only nuclear plant where surveys were done to find birds that collided with off-site lines. The plant's 1978 annual report presented a 5-year study of bird collisions with transmission lines near the river. Counts were conducted by walking several transects, usually on a weekly basis from April 22 through May 27 from 1974 through 1978. A total of 453 birds were found over the entire 5-year period of observation, primarily passerines (songbirds), mourning doves, ring-necked pheasants, and American coots. Waterbirds included 11 sora rails, 8 wood ducks, 3 mallards, 2 black ducks, 1 great blue heron, 1 ruddy duck, and 1 hooded merganser. No raptors were found. Most collisions apparently occurred during inclement weather. Scavengers probably removed many bird carcasses before they could be found.

Available literature on transmission line collision mortality is insufficient to determine conclusively whether bird populations are being significantly affected. Rather, existing data suggest that transmission lines associated with nuclear plants are probably responsible for only a small fraction of total collision mortality for transmission and distribution lines in general. Also, existing literature suggests that total collision mortality (cumulative impacts) associated with all types of man-made objects is not reducing bird populations significantly.

Based on (1) the fact that existing literature does not show significant impacts of collision mortality on overall species populations and (2) the lack of known instances where nuclear-plant lines are affecting large numbers of individuals in local areas, the staff concludes that the mortality resulting from bird collisions with transmission lines associated with license renewal and an additional 20 years of operation will not cause long-term reduction in bird populations and thus will be of small significance. Further, little potential for significance due to cumulative impacts is indicated. Finally, the modification of transmission lines would not be warranted because the impact is so small and such mitigation measures would be costly. This is a Category 1 issue.

4.5.6.3 Impacts of Electromagnetic Fields on Flora and Fauna

The effects of electromagnetic fields on terrestrial biota are considered to be of small significance if the overall health, productivity and reproduction of individual species appears unaffected.

The EMFs produced by operating transmission lines up to 1100 kV have not been reported to have any biologically or economically significant impact on plants, wildlife, agricultural crops, or livestock (DOE/BP-945; Miller 1983). Areas under and in the vicinity of the lines have been studied numerous times. Vegetation, foliar damage due to EMF-induced corona at leaf margins, agricultural crop production, wildlife population abundance, livestock production, and potential livestock avoidance of the lines have been investigated. Also, many laboratory experiments with plants and laboratory animals have been conducted, often using electric fields much stronger than those occurring under transmission lines.

4.5.6.3.1 Plants

Studies have shown that minor damage to plant foliage and buds can occur in the vicinity of strong electric fields. For example, tree foliage and buds that are close to transmission lines can be damaged and upward or outward growth of branches can be reduced. Damage typically occurs only to the tips and margins of leaves in the uppermost plant parts that are the closest to the lines. The damage in the form of a leaf burn is most prevalent on small pointed leaves and is similar to leaf damage that might occur as a result of drought or other environmental stresses. The damage generally does not interfere with overall plant growth (Miller 1983).

The damage is thought to result from heating caused by induced corona at the leaf tips and margins. The electric field is greatly focused by leaf points or marginal teeth, thus increasing its strength to the point that corona (Section 4.5.1.3) occurs. Night-vision instruments have shown this corona as a glow of light concentrated at leaf tips and margins. The damage apparently does not extend to lower levels of the plant because the electric field weakens with distance from the lines and because the upper plant parts shield the lower parts from the electric field.

In one experiment under an 1100-kV prototype line, the upward growth of alder and Douglas fir trees was reduced by this damage, with the result that the crowns of the trees became somewhat flattened on top and the overall crown developed a broader appearance than usual (Rogers et al. 1984). The growth of the lower parts of the trees and of lower-growing plants such as pasture grass, barley, and peas appeared unaffected (Rogers and Hinds 1983). In another experiment, 50-kV/m fields had no apparent effect on corn germination or the growth of corn seedlings; and the growth of corn, bluegrass, and alfalfa apparently was not affected by fields of 25–50 kV even though minor damage occurred to the outer fringes of the uppermost leaves (Bankoske et al. 1976). Germination of sunflower seeds in a 5-kV/m electric field was reduced by about 5 percent in some cases [4 out of 11 replicates (Marino et al. 1983)]. An experiment with several species of agricultural plants found that a maximum of about 1 percent of the total plant tissue was damaged by exposing the plants to 50-kV/m fields (Poznaniak and Reed 1978).

Lee (DOE/BP-945) reviewed several papers reporting studies in Indiana, Tennessee, and Arkansas. The productivity of corn and other crop plants was not affected by electric fields of 12 to 16 kV/m under a 765-kV line and a UHV test line in Indiana, although plants under the larger line suffered some leaf tip damage from induced corona. Corn production in Tennessee may have been reduced by electric fields up to 8.5 kV/m, but the authors indicated the results were inconclusive. An Arkansas study found normal yields of rice and soybeans but a 15 percent reduced yield of cotton beneath a 500-kV line (see Section 4.5.3). The researchers could not determine whether the reduced cotton yield resulted from electric field or ineffective aerial application of agricultural chemicals beneath the line.

4.5.6.3.2 Honeybees

Several studies have shown that honeybees in hives under transmission lines are affected by EMF (EA-4218; Rogers and Hinds 1983; Warren et al. 1981). Adverse effects include increased propolis (a reddish resinous cement) production, reduced growth, greater irritability, and increased mortality. These effects can be greatly reduced by shielding the hives with a grounded metal screen or by moving the hives away from the lines (Rogers and Hinds 1983; Lee 1980). V. P. Bindokas et al. (1988) showed that these impacts were not caused by direct effects of the electric fields on the bees but by voltage buildup and electric currents within the hives and the resultant shocks to bees. Bees kept in moisture-free nonconductive conditions were not adversely affected, even in electric fields as strong as 100 kV/m.

4.5.6.3.3 Wildlife and Livestock

Chronic exposure to EMF is experienced by small birds and mammals that primarily inhabit ROW corridors and by birds (primarily raptors) that nest in transmission line towers. EMF exposures to larger animals and livestock are usually relatively brief because these animals inhabit relatively large areas instead of small areas beneath the lines. Exposures occur as these larger animals pass beneath the lines or as birds fly by the lines.

The voluminous literature on population studies of small bird and mammal species in transmission line corridors (Section 4.5.6.1) has expressed virtually no concern for possible impacts of EMF. These species apparently thrive underneath the lines, where their abundance appears to depend on habitat quality rather than on the strength of the electric fields to which they are exposed or the size of the line. For example, the density of breeding birds under 500-kV lines in eastern Tennessee is greater than that in adjacent forests (Kroodsma 1984c, 1987) and appears to be greater than bird density in most grassland habitats or agricultural fields. Also, the density of small mammal populations near these lines appears to depend on habitat type rather than on the presence of the lines (Schreiber et al. 1976). A Minnesota study of a 500-kV line found little evidence of either a positive or negative effect of the power line on bird populations (Niemi and Hanowski 1984). Bird and small mammal populations under an 1100-kV line in Oregon were also apparently unaffected by line operations (Rogers and Hinds 1983). Habitat use by elk in western Montana was apparently unaffected by operation of a 500-kV line, as the elk used habitats along the power line in proportion to their availability (DOE/BP-1136).

Raptors, ravens, and some water bird species frequently nest and perch on transmission line towers, particularly in grassland areas where other suitable nest sites are lacking.[6] Thus, the birds are able to use habitats without suitable nest sites—habitats that they otherwise would not have used (Gilmer and Stewart 1983; Williams and Colson 1989). On high-voltage lines supported by metal lattice towers, the birds usually nest on the top (bridge) of the tower where the strength of the electric field is minimal (e.g., 5 kV/m or less) (Lee 1980). Lee found 80 percent of 110 nests on towers to be located on the tower bridge and cited previous studies that showed similar results.

The success of these tower nests in producing young appears to be no different from nests located in areas not exposed to EMF. In central North Dakota, 113 ferruginous hawk nests in high-voltage transmission line towers (18 percent of a total of 628 nests found) had a higher success rate (87 percent) than nests in other locations (however, a hail storm that missed the lines reduced the success of some other nests). The number of fledglings per occupied nest was 2.8 for ground nests (which were larger than tower or tree nests), 2.6 for tower nests, 2.3 for haystack nests, and 2.0 for tree nests (Gilmer and Stewart 1983). In Idaho, Steenhof et al. (1993) studied nesting success of ravens and raptors on a 576-km (370-mile) segment of 500-kV transmission line constructed in 1981. From 1981 through 1989 (the last year reported by Steenhof et al.), the numbers of these species nesting on transmission towers increased to 133 pairs, including roughly 64 percent common ravens, 21 percent red-tailed hawks, 9 percent ferruginous hawks, 6 percent golden eagles, and 0.3 percent great horned owls. Nesting success of these birds averaged 65 percent to 86 percent and was similar to or better than that of the same species nesting on other substrates. Lee (1980) reported finding 110 hawk and raven nests on 260 miles of 230-kV and 500-kV lines of the Bonneville Power Administration. Although the success of these nests was not monitored, the author reported that, based on a literature review, it was unlikely that nesting would be adversely affected by EMF found in most locations in transmission line towers.

Livestock in both field and laboratory studies have shown no significant impacts when exposed to EMF. In DOE/BP-945, J. M. Lee reviewed about 10 reports on effects of transmission lines on livestock in the United States and Sweden. These studies found no evidence that the growth, production, or behavior of beef and dairy cattle, sheep, hogs, or horses were affected by EMF. The studies involved 11 farms along a 765-kV line in Indiana, 55 dairy farms near 765-kV lines in Ohio, 36 herds of cattle near 400-kV lines in Sweden, a mail survey of 106 farms in Sweden, a study of fertility of 58 cows under a 400-kV line in Sweden compared with 58 in a control area, 30 swine raised beneath a 345-kV line in Iowa compared with 30 raised in a control area, and cattle behavior under an 1100-kV prototype line in Oregon. Cattle under the 1100-kV test line in Oregon were startled by the first occurrence of corona noise when the line was reenergized after a shutdown period (Rogers and Hinds 1983). From 1977 through 1981, grazing of cattle in pasture under the line appeared to be unaffected by line operation. In 1980–81, the cattle spent more time near the line during periods when it was deenergized than when it was operating, but spent an increasing amount of time under the line when it was operating as the growing season progressed (Rogers and Hind 1983).

In the Indiana study (Amstutz and Miller 1980), performance of livestock frequently under a 765-kV line on 11 farms was studied during a 2-year period (1977–1979; 9 farms participated for the full 2 years). Animals included 10 horses, 55 sheep, 149 beef cattle, 337 hogs, and 429 dairy cattle. Maximum field voltage levels recorded near ground level were about 9.1 kV/m. General health, behavior, and performance of the animals were not affected by the transmission line EMF.

In the Swedish study of cow fertility, 58 heifers were exposed to a 400-kV, 50-Hz transmission line from June to mid-October 1985 (Algers and Hultgren 1987). The length of exposure was 15 to 20 times longer than the average exposure per year for Swedish dairy herds exposed to 400-kV lines. No effects were observed on the frequency of malformations, the length or variation of the estrous cycle, the midcycle plasma progesterone level, the intensity of estrus, the number of inseminations per pregnancy, the overall conception rate, or the fetal viability. Previous studies of cattle showed no significant effects of EMF on reproduction.

4.5.6.3.4 Conclusion

No significant impacts of EMF on terrestrial biota have been identified. Although foliage very close to lines can be damaged, the overall productivity and reproduction of native and agricultural plants appear unaffected. Also, no evidence suggests significant impacts on individual animals or wildlife populations that are chronically exposed to EMF under transmission lines or in the towers. Livestock behavior and production also appear unaffected by line operation. Therefore, the potential impact of EMF on terrestrial biota is expected to be of small significance for all plants. The only potential mitigation would be to exclude plants and animals from the right of way, a measure with very severe impacts of its own. However, because the impact is of small significance and because mitigation measures could create additional environmental impacts and would be costly, no mitigation measures beyond those implemented during the current term license would be warranted. This is a Category 1 issue.

4.5.7 Floodplains and Wetlands

Transmission lines pass through floodplains and wetlands in many areas. This section evaluates the impacts on floodplains and wetlands that may result from periodic cutting or herbicide treatment of woody vegetation and the occasional use of heavy equipment for line repair. The analysis in this section is based on a literature review and applies to all power lines regardless of the type of generating facility.

Vegetation control is normally required only in forested areas where trees could grow tall enough to interfere with line operation. Marshes, ponds, or other types of wetlands lacking trees generally should not be subjected to vegetation control and thus should not be affected. In forested wetlands, most of which are on floodplains, vegetation may be cut by hand or with a tractor with a rotary blade or may be controlled by herbicides (Section 4.5.1.4). Impacts are generally restricted to the ROW and should have no significant impact on the functions and values that have been identified for floodplains, including storage and slow release of floodwaters, water quality maintenance, groundwater recharge, and support of wildlife populations (Greeson et al. 1979). Herbicides that are often used in prairie wetlands to improve habitat for waterfowl do not appear to have toxic effects on aquatic biota (Solberg and Higgins 1993).

Repair of transmission lines may require access by heavy equipment to tower sites in floodplains or wetlands. This access would damage vegetation and disturb wildlife, having the same types of impacts that occurred during construction of the line. Overall impacts are expected to be relatively minor because (1) line repairs at any one location are rarely required, (2) impacts would be temporary and restricted to relatively small areas, and (3) tower sites often avoid wetlands. Repairs made during winter would generally have less impact than repairs in summer, but often there may be no choice of season because of the necessity for immediate repair.

Studies in Massachusetts indicate that transmission lines and their ROW can be constructed and maintained through wetlands without significant impact (Nickerson and Dobberteen 1987; Thibodeau and Nickerson 1986). The studies were conducted in several areas where 345-kV lines were constructed through cattail marsh, wooded swamp, and shrub swamp/bog. Preconstruction studies were done in 1975 and 1976, and postconstruction studies were done from 1977 to 1982 and again in 1987. The cattail marsh was affected by the placement of heavy oak mats that were required so that heavy construction equipment could enter the marsh. This was done during the winter when the marsh was frozen and aerial parts of plants were dead. The marsh recovered to its original condition in 1 year. Line maintenance or repair using heavy equipment, if required, could be conducted during winter with no greater harm to a marsh.

In a bog, although vegetation was damaged by placement of oak mats and had not fully recovered after 10 years, the number of plant species in affected areas did not differ significantly from that in control areas. The authors recommended that line construction avoid bogs because of their extremely slow recovery.

Wooded swamp dominated by red maple showed significant change in vegetation structure because trees had to be removed from the ROW. After construction, the number of species and individuals returned to normal after 1 year, and a shrub layer became the dominant vegetation. After 10 years, the number of plant species in the ROW was greater than that in undisturbed swamp, even though the ROW vegetation had been mowed once (at a level of 3 ft) 6 years after construction. Because of the rapidity of swamp recovery after construction and the stability of the maintained ROW vegetation, the authors concluded that there was no substantial negative impact on wetland functioning. On swamp ROW cleared for lines from 1936 through 1939, selective cutting and herbicide treatment of cut stumps had been conducted. The numbers of species and individuals were similar to those in adjacent forest, and the ROW showed little evidence of disturbance except where trees had recently been cut (Nickerson and Dobberteen 1987; Thibodeau and Nickerson 1986).

No transmission line associated with a nuclear plant has been identified as being a significant impact on the functions and values of a wetland or floodplain. Only minor impacts of small significance are expected from ROW maintenance or line repair. Because the impact is of small significance and mitigation measures would be costly to implement, none of the mitigation measures identified above (i.e., placement of oak mats in affected areas and avoidance of maintenance during the growing season) would be warranted. This is a Category 1 issue.

4.5.8 Aesthetic Resources

This section evaluates the issue of transmission-line-induced impacts of continued operation of nuclear power plants on historic and aesthetic resources. Transmission lines are probably the most frequently seen equipment associated with power plants, particularly plants such as D. C. Cook or Diablo Canyon that are well hidden from public view. Transmission lines are the least novel in appearance when compared with highly visible nuclear power plant components such as cooling towers and containment vessels. Therefore, they are perceived with less bias than other components of the nuclear power plant complex. People may not even realize that some transmission lines are associated with a particular power plant, especially a nuclear plant.

The definitions of insignificant, noticeable, and significant levels of impact are the same as those described in Section 3.7.8.

The evaluation of past and projected future impacts of transmission lines on aesthetic resources involved staff examination of the experience at the seven selected case study sites, a brief survey of the projected and realized aesthetic impacts at the other operating nuclear power plants, a survey of the professional literature, and a search of recent newspaper and magazine accounts related to these issues.

Nuclear power plants are frequently sited near bodies of water for access to cooling water; their associated transmission lines often intrude into recreation, historic, or scenic areas. Most of the adverse impacts to date from transmission lines center on such incompatibility. Notable examples include Brunswick, Diablo Canyon, Millstone, Nine Mile Point, St. Lucie, and Vogtle. Crossings of major rivers, wetlands, wildlife areas, roads, lakes, cemeteries, and battlefields are the source of the disputes that have arisen. Various design, engineering, siting, construction, and metallic surface treatments have been made available to mitigate these conflicts.

In general, during the license renewal term, continued use of transmission lines and ROW is projected to cause little or no additional impacts beyond those that have already occurred. Some habituation to lines is likely to occur or continue. The problem of erosion of access roads under transmission lines at Diablo Canyon represents a type of impact that could worsen over time if mitigation is not effectively implemented. Proper maintenance of the t ransmission line corridor will help prevent aesthetic degradation. Additional mitigation measures such as replacement of towers or burying the transmission line would be excessively costly and would have additional environmental impacts.

The aesthetic impacts associated with continued operation of transmission lines are of small significance for all plants, and no mitigation measures beyond those implemented during the current term license would be warranted. This is a Category 1 issue.

4.6 RADIOLOGICAL IMPACTS OF NORMAL OPERATION

This section provides an evaluation of the radiological impacts on occupational personnel and members of the public during normal operation following license renewal. This evaluation extends to all 118 nuclear power reactors. Radiation exposures occurring after license renewal are projected based on present levels of exposures. Estimates of additional maintenance, testing, and inspections as a result of a variety of age-related changes in operational procedures were made based on the anticipated changes to current operation and are detailed in Section 2.6 and Appendix B. Added maintenance, testing, and inspection will be accompanied by increased exposure time to members of the work force but are not expected to significantly influence dose to members of the public. Regulatory requirements under which nuclear reactors presently operate are discussed in Section 3.8.1.1.

A detailed discussion is provided in Chapter 6 of the radiological impacts of low-level waste, mixed waste, and spent fuel generated by power reactors during the renewal period; the impacts attributable to the uranium fuel cycle; and the impacts of the transportation of fuel and waste.

In response to comments on the draft GEIS and the proposed rule, the standard defining a small radiological impact has changed from a comparison with background radiation to sustained compliance with the dose and release limits applicable to the activities being reviewed. This change is appropriate and strengthens the criterion used to define a small environmental impact for the reasons that follow. The Atomic Energy Act requires NRC to promulgate, inspect, and enforce standards that provide an adequate level of protection of the public health and safety and the environment. These responsibilities, singly and in the aggregate, provide a margin of safety. The definitions of the significance level of an environmental impact (small, moderate, or large) applied to most other issues addressed in this GEIS are based on an ecological model that is concerned with species preservation, ecological health, and the condition of the attributes of a resource valued by society. Generally, these definitions place little or no weight on the life or health of individual members of a population or an ecosystem. However, health impacts on individual humans are the focus of NRC regulations limiting radiological doses. A review of the regulatory requirements and the performance of facilities provides the bases to project continuation of performance within regulatory standards. For the purposes of assessing radiological impacts, the Commission has concluded that impacts are of small significance if doses and releases do not exceed permissible levels in the Commission's regulations. This definition of "small" applies to occupational doses as well as to doses to individual members of the public. Accidental releases or noncompliance with the standards could conceivably result in releases that would cause moderate or large radiological impacts. Such conditions are beyond the scope of regulations controlling normal operations and providing an adequate level of protection. Given current regulatory activities and past regulatory experience, the Commission has no reason to expect that such noncompliance will occur at a significant frequency. To the contrary, the Commission expects that future radiological impacts from the fuel cycle will represent releases and impacts within applicable regulatory limits.

4.6.1 Public Exposure

During normal operations after license renewal, small quantities of radioactivity (fission, corrosion, and activation products) will continue to be released to the environment in a manner similar to present operation. Analyses of historic effluent data presented in Appendix E have pointed to a systematic reduction in effluents (primarily airborne). While there is no empirical evidence of a leveling off, there will be a practical lower limit of effluent release.

Radioactive-waste management systems are incorporated into each plant and are designed to remove most of the fission-product radioactivity that leaks from the fuel, as well as most of the activation- and corrosion-product radioactivity produced by neutrons in the vicinity of the reactor core (Section 2.2). Improved fuel integrity in the 1980s was an important factor in reducing effluents. In addition, the effectiveness of the gaseous and liquid treatment equipment has increased significantly over the past two decades, as is evidenced by the continuously decreasing levels of effluents (NUREG/CR-2907). The amounts of radioactivity released through vents and discharge points to areas outside the plant boundaries are recorded and published semiannually in the radioactive effluent release reports for each facility. A discussion of the environmental pathways for radioactive effluent releases to the air and water was presented in Section 3.8.1.2. This section will focus on issues more unique to license renewal.

4.6.1.1 Radionuclide Deposition

The concentration of radioactive materials in soils and sediments builds up to an equilibrium value that depends on the rate of deposition and the rate of removal. Removal can take place through radioactive decay or through chemical, biological, or physical processes. For a given rate of release, the concentrations of longer-lived radionuclides and consequently the dose rates attributable to them would continue to increase if license renewal were granted.

In Regulatory Guide 1.109, explicit guidance is provided for calculation of dose for nearly all conceivable pathways. To account for the buildup of radioactive materials, buildup factors of the form $(1 - e^{-\lambda t})$ in the calculations are included, where λ is the radionuclide decay constant, and t is the midpoint of a facility's operational life. Hence, only radioactive decay is used in the removal term. Initially, most of the calculations for construction and operating stage permits used 15 years as the approximate midpoint of facility operating life. This value is now more often taken to be 20 years. The potential license renewal term is an additional 20 years; thus, the effective midlife is 30 years.

At present, most of the radiation dose commitments to the population resulting from atmospheric emissions are from the noble gases (NUREG/CR-2850 1993). The noble gases do not build up in the environment. Iodine-131, of interest because it has the ability to concentrate in the thyroid, achieves equilibrium within weeks. Tritium, cobalt, and cesium normally account for the greatest proportion of the dose from liquid effluents. Tritium is not known to concentrate in sediments or solids and hence does not build up. To determine whether the added period of operation following license renewal would, by virtue of buildup, result in significant (double) added dose, the ratios of buildup factors for midlives of 30 to midlives of 20 years were evaluated. These ratios amount to a 35 percent increase for ^{137}Cs and a 6 percent increase for ^{60}Co. This added increase due to buildup will not significantly change the total dose to members of the public.

One remaining topic about buildup in the environment warrants discussion. Buildup is not explicitly accounted for in the aquatic food pathway (i.e., fish, shellfish, etc.) This pathway relies on the use of bioconcentration factors. A bioconcentration factor for a nuclide is the ratio of the concentration in biota to the radionuclide concentration in water. In certain cases, the bioaccumulation factors may require reexamination. These principally involve fish (in the human food chain) that are bottom feeders. Bottom feeders may ingest worms and other biota that may remobilize radioactive materials accumulated in the sediments.

Accumulation of radioactive materials in the environment is of concern not only to license renewal, but also to operation under present licenses. NRC reporting rules require that pathways that may arise as a result of unique conditions at a specific site considered in licensees' evaluations of radiation exposures. If an exposure pathway is likely to contribute significantly to total dose (10 percent or more to the total dose from all pathways), it must be routinely monitored and evaluated. Environmental monitoring programs are in place at all sites to provide a backup to the calculated doses based on effluent release measurements. Since these programs are ongoing for the duration of the license, locations where unique situations give rise to significant pathways not detailed in NRC Regulatory Guide 1.109 will be identified if and when they become significant. If such pathways result in doses at a plant exceeding the design objectives of Appendix I to 10 CFR Part 50, action will be required.

4.6.1.2 Direct Radiation

Radiation fields are produced around nuclear plants as a result of radioactivity within the reactor and its associated components, low-level storage containers, and components such as steam generators that have been removed from the reactor (as described in Section 3.8). Direct radiation from sources within a light water reactor plant is due primarily to ^{16}N, a radionuclide produced in the reactor core by neutron activation of ^{16}O from the water. Because the primary coolant of an LWR is contained in a heavily shielded area, dose rates in the vicinity of light water reactors are generally undetectable and are less than 1 mrem/year at the site boundary. Some plants [mostly boiling water reactors (BWRs)] do not have completely shielded secondary systems and may contribute some measurable off-site dose. These sources of direct radiation will be unaffected by license renewal.

Original impact statements were reviewed for estimates of off-site dose from radioactive storage containers at both boiling-water reactors and pressurized-water reactors. These estimates suggested small dose contributions at site boundaries (Section 3.8.1.6). Nothing is anticipated to occur during license renewal to significantly change this estimate.

4.6.1.3 Transportation-Related Radiation Doses

The transportation of "cold" (unirradiated) nuclear fuel to the reactor, of spent irradiated fuel from the reactor, and of solid radioactive wastes from the reactor to a waste burial ground represents a source of exposure considered in 10 CFR Part 51.52. The contribution of the environmental effects of such transportation to the environmental costs of license renewal of the nuclear power reactor is set forth in Summary Table S-4 from 10 CFR 51.52. This issue is discussed in Section 6.4.

4.6.1.4 Radiological Monitoring

Background measurements at all sites were obtained during the preoperational phase of the monitoring program. Thus, each facility has characterized the background levels of radioactivity and radiation and their variations among the anticipated important pathways in the areas surrounding the facilities. The operational, off-site radiological monitoring program is conducted to provide data on measurable levels of radiation and radioactive materials in the site environs in accordance with 10 CFR Parts 20 and 50. The program assists and provides backup support to the effluent-monitoring program recommended in NRC Regulatory Guide 1.21, *Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants*. Such environmental monitoring programs are conducted to augment dose calculations and to ensure that unanticipated buildups of radioactivity will not occur in the environment.

The environmental monitoring programs also identify the existence of effluents from unmonitored release points. An annual survey (land census) identifies changes in the use of unrestricted areas to provide a basis for modifying the monitoring programs.

4.6.2 Public Radiation Doses

Doses to the public during the license renewal term were estimated using current (baseline) levels and trends. For the period after license renewal, two measures of impact are appropriate. They are the dose to the maximally exposed individuals and the population dose. The latter is the average individual dose as a function of distance and sector location multiplied by the population in that sector at that distance.

4.6.2.1 Maximally Exposed Individual

Table 4.6 presents the dose to the maximally exposed individual resulting from airborne effluents as tabulated by NUMARC (1989) for the years 1985 to 1987. Under most circumstances, the dose calculations, made by the reporting utilities, result in an overestimate of dose because of conservative assumptions. The table shows that the greatest dose value for the maximally exposed individual from atmospheric releases (between 1985 and 1987) is 4.3 mrem.[7] On the average, about 5 percent of the sites report an annual dose of 1 mrem or greater to the maximally exposed individual. NRC has recently begun to estimate individual doses for comparison with 10 CFR Part 50, Appendix I objectives (NUREG/CR-2850 1994). Combining air and liquid pathways for calendar year 1990, operation at about 5 percent of the sites resulted in annual

Table 4.6 Calculated total body dose to the maximally exposed individual from routine airborne effluents (mrem)

Plant	1985	1986	1987
Arkansas, Unit 1	—	0.0017	0.0023
Arkansas, Unit 2		0.006	0.0044
Beaver Valley	—	0.023	0.0014
Brunswick	—	—	0.028
Catawba	0.88	2.2	0.89
D. C. Cook	0.057	0.02	0.024
Cooper	0.57	0.4	0.018
Crystal River	0.022	0.21	0.2
Davis-Besse	0.0081	0.00064	0.12
J. M. Farley	0.13	0.12	0.081
Grand Gulf	0.09	0.068	0.34
Haddam Neck	1.0	0.39	0.66
Oconee	0.15	0.087	—
Oyster Creek	1.4	4.3	0.17
Peach Bottom	0.041	0.12	0.015
Pilgrim	0.49	0.027	—
Quad-Cities, Unit 1	0.002	—	0.0025
Quad-Cities, Unit 2	0.002	—	0.0021
Rancho Seco	0.17	—	—
H. B. Robinson	—	0.016	0.068
Shearon Harris	—	—	0.022
E. I. Hatch	0.093	0.004	0.13
Indian Point	0.00078	0.00049	—
Kewaunee	—	0.12	0.00001
Limerick	—	0.00079	0.00022
McGuire, Unit 1	—	0.15	0.081
McGuire, Unit 2	1.8	—	0.0036

Table 4.6 (continued)

Plant	1985	1986	1987
Salem	0.016	0.028	0.047
Sequoyah	0.19	0.002	—
St. Lucie, Unit 1	0.013	0.011	0.0023
St. Lucie, Unit 2	0.0062	0.0021	0.0028
V. C. Summer	—	0.00051	0.000001
Susquehanna	0.1	0.0069	0.011
Three Mile Island	—	0.019	0.0028
Trojan	0.069	—	—
Turkey Point, Unit 1	—	0.0038	0.0087
Turkey Point, Unit 2	—	0.0042	0.0088
Waterford	—	—	0.66
Washington	—	0.013	0.024
Zion	0.044	0.092	0.00047

Source: NUMARC 1989.
Note: To convert millirem to millisievert, multiply by 0.01.

doses of 1–3 mrem to the total body; 32 percent of the sites, 0.1–1.0 mrem; and 63 percent of the sites, less than 0.1 mrem. A comparison of the data from Table 4.6 and from NUREG/CR-2850 (1994) with the design objective doses of Appendix I to 10 CFR Part 50 and the EPA dose limits (Section 3.8.1) shows that existing plants are operating far below allowable limits with respect to effluent control.

Given the conservative nature of the calculations leading to the doses of Table 4.6, the impact on maximally exposed persons around nuclear generating facilities is clearly very small.

4.6.2.2 Average Individual Dose and Population Dose Commitment

4.6.2.2.1 Recent Data

Trends for average individual doses for persons living around nuclear power plants reflect the small radiation dose levels seen in the maximally exposed individuals. Each year, NRC issues a report entitled *Population Dose Commitments Due to Radioactive Releases from Nuclear Power Plant Sites*. The latest publication is for the calendar year 1989 (NUREG/CR-2850, Vol. 11). Methods used in this series are described in Section 3.8.1. The prescribed calculational methods include several basic assumptions to ensure that the results are conservative. Table 4.7 (adapted from

Table 4.7 Summary of population and occupational doses (person-rem) for all operating nuclear power plants combined

Year	Population			Occupational
	Liquid	Air	Total	
1975	76	1,300	1,300	20,879
1976	82	390	470	26,107
1977	160	540	700	32,508
1978	110	530	640	31,801
1979	220	1,600	1,800	39,982
1980	120	57	180	53,795
1981	87	63	150	54,144
1982	50	87	140	52,190
1983	95	76	170	56,472
1984	160	120	280	55,235
1985	91	110	200	43,042
1986	71	44	110	42,381
1987	56	22	78	40,401
1988	65	9.6	75	40,769
1989	68	16	84	35,980
1990	—[a]	—	—	35,592
1991	—	—	—	28,515
1992	—	—	—	29,309

[a]Data not available.
Source: NUREG/CR-2850; NUREG-0713
Note: To convert person-rem to person-sievert, multiply by 0.01.

NUREG/CR-2850 and NUREG-0713) presents results obtained for a 15-year period ending in 1989. The numerical entries are person-rem received by those who live within a 50-mile radius of a site; data for individual sites also appear in these reports. The person-rem number is obtained by adding together the individual doses received by this population. For 1988, the cumulative person-rem varied from a low of 0.0015 at Grand Gulf to a high of 16 at McGuire. Seventy-five percent of the total came from 9 of the 67 sites, as shown in Table 4.8. (Information presented in Tables 4.8 and 4.9 was derived from NUREG/CR-2850, Vol. 10,

Table 4.8 Highest public dose data from nuclear power plant effluents, 1988

Plant	Population dose (person-rem)	Population within 50 miles (persons)	Average individual dose (mrem)
McGuire	16	1,800,000	0.0091
Summer	13	900,000	0.014
Zion	7.2	7,300,000	0.001
E. I. Hatch	6.4	350,000	0.018
Clinton	4	2,700	0.0015
Oconee	3.8	9,900	0.0039
Oyster Creek	2.2	3,600,000	0.0006
Harris	1.8	1,400,000	0.0013
Calvert Cliffs	1.7	2,800	0.00061
All sites	75	150,000,000[a]	0.0005

[a]This figure is inflated because not all sites are 100 miles apart, and some persons within each 50-mile radius were counted more than once.
Source: Adapted from NUREG/CR-2850, Vol. 10.
Note: To convert rem to sievert, or mrem to millisievert, multiply by 0.01.

Table 4.9 Individual public dose data from power plant effluents, 1988

Individual dose range (mrem)	Percentage of total	Cumulative percentage
0 to 0.000001	6 percent	6 percent
0.000001 to 0.00001	4 percent	10 percent
0.00001 to 0.00003	18 percent	28 percent
0.00003 to 0.0001	30 percent	58 percent
0.0001 to 0.0003	21 percent	79 percent
0.0003 to 0.001	13 percent	92 percent
0.001 to 0.003	5 percent	97 percent
0.003 to 0.01	< 2 percent	99 percent
0.01 to 0.03	< 1 percent	100 percent

Source: NUREG/CR-2850, Vol. 10.
Note: To convert mrem to millisievert, multiply by 0.01.

the most recent volume which presents data summaries with average individual doses.) The arithmetic mean annual radiation dose to people who lived in the vicinity of a U.S. nuclear power plant in 1988 was about 0.0005 mrem. The overall median for 1988 was less than 0.0003 mrem. A histogram shown in Figure 4.1 of NUREG/CR-2850 provided the information shown in Table 4.9.

Note that 97 percent of the individuals received 0.003 mrem or less during 1988. The most recent NCRPM report on this subject gives 300 mrem/year as the U.S. average dose from natural background radiation (NCRPM 1987). The addition of 0.018 mrem at the Hatch site as a result of plant operation is well within and indistinguishable from variations in natural background radiation (see Dudney et al. 1990).

According to the National Council on Radiation Protection and Measurements report, if a person moves from the coast to the Rocky Mountains, the natural annual doses can be increased by as much as 70 mrem. This 70-mrem addition to natural background which occurred because of a personal relocation is 7690 times greater than the average dose from operation of the McGuire nuclear facility during 1988.

4.6.2.2.2 Analysis of Current Trends

Projections into the future can be made on the basis of current trends. On that basis, average individual dose commitments were analyzed. The first objective of the analysis was to determine to what extent known information about all sites could be used to predict what the dose commitment values for each site were for the years 1979–1987. The second objective, if current dose commitments could be predicted adequately, was to use the models to predict future dose commitments for U.S. sites by extrapolating the characteristics used in the model and the population projections for the sites into future years (see Section E.3.2 for more details of this analysis).

A linear model was fitted to the dose data using combinations of independent variables. The independent variables that proved to be most predictive of the log (dose) values included calendar year, year of startup, size in megawatts, vendor (or manufacturer), and status (up or down). The linear model for estimation of air doses resulted in the following conclusions. The manufacturer with the highest air doses is Babcock-Wilcox (B-W) (but highly variable); the next highest is GE; and the lowest is Combustion Engineering (C-E). Air doses are decreasing with calendar year (for 1979 to 87) for all reactor types. The rate of decrease is fastest for GE reactors. The rate of decrease is much smaller for C-E reactors than for others, partly because these are lower to begin with. With the exception of C-E, all types have higher air doses from older reactors. For C-E, newer reactors have higher doses. Larger reactors had higher air doses. This relationship was strong and was a major contributor to the prediction of dose for each reactor site; it held true for all manufacturers but was much less evident in B-W reactors. The increase in air dose with size was largest for GE and for Westinghouse reactors. The overall model accounts for approximately 42 percent of the variation in the air dose values. For all reactor types (manufacturers), air doses decrease significantly when the reactor is operating below 25 percent capacity. This is not necessarily true for doses from liquid sources.

The linear model for estimating liquid dose resulted in the following conclusions: B-W reactors have significantly higher liquid doses than do reactors of other manufacturers, and GE reactors are next highest. Mixed sites (those with multiple reactors and different vendors) have the lowest liquid doses. GE and mixed sites have higher doses from liquid sources when they are operating below 25 percent of theoretical maximum output. Many mixed sites are partly GE reactors. All other manufacturers, all of which are pressurized-water reactors, have lower doses when they are operating below 25 percent capacity. Liquid doses are higher in older reactors only for GE reactors. For others, there is not a significant trend with reactor age. For GE reactors and for Westinghouse reactors, the larger reactors had higher liquid doses. The increase in liquid dose with megawatt capacity was much higher for GE reactors than for the other types. Liquid doses are overall much less predictable than air doses, and the resulting model fit for the liquid doses reflects this unpredictability. For liquid doses, the best-fitting model accounted for only about 20 percent of the overall variability in the model.

Liquid effluents are not decreasing significantly with time for any of the five types, although the coefficients are negative except for the mixed sites. Thus, the general trend with time is for air doses to decrease and for doses from liquid sources to decrease less rapidly. The decreasing trend in total dose commitment results mostly from the lower air dose estimates.

On the basis of the coefficients estimated with this analysis, it is apparent that the dose commitments are being systematically lowered. Results of the analysis were used to plot historical data against predicted doses (see sample figures in Section E.3). These figures portray how each sample reactor has performed with respect to other reactors in its class (i.e., age, size, vendor). Again, the dominant theme is the decline in dose commitment, which is almost universally observed. Even if there were a sudden cessation of the decline in dose to the public, levels are sufficiently low to represent an insignificant impact to humans.

4.6.2.3 Projected Doses for License Renewal

On the basis of information presented in the preceding section, radiation doses to members of the public can be projected into the license renewal period. The three factors upon which judgments can be made are the maximally exposed individual, the average exposed individual, and the cumulative exposure of a population. At present, each of these measures meets the design objectives and regulations. No aspect of future operation was identified that would substantially alter this situation. Rather, evidence presented above suggests that radioactive effluents and hence doses to the public are decreasing.

Maximum individual doses are reported in semiannual effluent release reports, and when these doses exceed Appendix I design objectives, the staff pursues remedial action. Thus these issues are handled on a case-by-case basis. A review of the atmospheric release data sources suggests that, in any given year, up to 5 percent of the power plants produce radiation doses of approximately 20 percent of the Appendix I design objectives (NUMARC 1989). No aging phenomenon has been identified which is expected to increase public radiation doses. Since the design objective provides a point of reference for visibility to the NRC staff, normally operating reactors are not expected to reach regulatory dose limits more often in the period after license renewal than they do at present. For these reasons, impacts to maximally exposed individuals in the public during future operation under license renewal are judged to be radiologically unchanged from present operations.

Similarly, radiation exposure to the average individual and collective dose to the population around a nuclear power plant are not anticipated to increase from present levels in the period after license renewal. Analysis of all available pertinent information suggests that, if anything, radiation doses to the public are decreasing.

Ninety-nine percent of the population within 50 miles of any plant received a dose of 0.003 mrem or less from nuclear power plant effluents in 1988 (Table 4.9). In 1990, the average dose to persons living within an 80-km (50-mile) distance from nuclear power plants was less than 0.001 mrem (NUREG/CR-2850 v. 12). If all 150 million people living within 80 km (50 miles) of nuclear plants receive 0.001 mrem/year for 70 years, the collective dose will be 10,500 person-rem. Using a risk coefficient of 5×10^{-4} cancer fatalities per person-rem, approximately 5 fatalities can be hypothesized. Among the 150 million people, about 30 million will die of spontaneous cancer. Hence, the added risk of cancer fatality is less than 1 in 6 million national cancer fatalities.

From a different perspective, the population of 150 million people would accumulate 45,000,000 person-rem/year from natural background radiation. The annual collective dose from operation of all 118 nuclear power plants, assuming an annual average individual dose as high as 0.002 mrem per person, is 300 person-rem. This is 150,000 times less than the collective dose from naturally occurring radiation. From this perspective, the contribution of nuclear power plants to the radiation dose to members of the public is not significant. Future increases in populations will result in proportional increases in population doses; that is, a doubling of the population around the 118 plants would result in a 600 person-rem annual collective dose. However, the population increase would not change the fact that the collective dose from plant operation is still 150,000 times less than that from naturally occurring radiation.

Cumulative impacts to average individual members of the public can be viewed from the same perspective presented in Section 3.8.1.7. During operation under license renewal, the average annual dose to the public from nuclear power plant operations will remain very small, less than 0.001 mrem/year. Cumulative radiation doses to members of the public will remain about 360 mrem/year and nuclear power plant operation will remain a very small part (less than 0.0003 percent) of the ionizing radiation dose to an average member of the U.S. population.

4.6.2.4 Mitigation

In addition to the regulations within 10 CFR Part 20.1101 (see Section 3.8.1.8) which speak directly to required operation under ALARA principles, 10 CFR Part 50.36a imposes conditions on licensees in the form of technical specifications on effluents from nuclear power reactors. These specifications are intended to keep releases of radioactive materials to unrestricted areas during operations to ALARA levels. Appendix I to 10 CFR Part 50 provides numerical guidance on dose-design objectives and limiting conditions for operation of LWRs to meet the ALARA requirements. These regulations will remain in effect during the period of license renewal.

Evidence presented in Section 3.6, Appendix E, and this section demonstrates that the ALARA process has been effective at controlling and reducing radiation doses to the public. Radiation doses to the public are declining both for average and total doses (Table 4.7) and for individual doses (Tables 4.10 and 4.11). No changes in the operation of power plants under license renewal are expected to increase radiation doses to the public compared with current operation. Because effective mitigation procedures are already in place, there is no need to consider additional mitigation during the period of license renewal.

4.6.2.5 Conclusion

Radiation doses to members of the public from current operation of nuclear power plants have been examined from a variety of perspectives and the impacts were found to be well within design objectives and regulations in each instance. No effect of aging that would significantly affect the radioactive effluents has been identified. Both maximum individual and average doses are expected to remain well within design objectives and regulations. In about 5 percent of the plants, maximum individual doses are approximately 20 percent of the Appendix I design objective. All other plants are operating far below this level.

Because no reason was identified to expect effluents to increase in the period after license renewal, continued operation well within regulatory limits is anticipated. The staff concludes that the significance of radiation exposures to the public attributable to operation after license renewal will be small at all sites. It should also be noted that the estimated cancer risk to the average individual due to plant operations is much less than 1×10^{-6}. No mitigation measures beyond those implemented during the current term license would be warranted because current mitigation practices have resulted in declining public radiation doses and are expected to continue to do so. This is a Category 1 issue.

4.6.3 Occupational Radiation Dose

To determine the significance of the estimated occupational dose during the license renewal term, the staff has examined the baseline trends in cumulative annual occupational dose at pressurized-water reactors and boiling-water reactors and the projected increments to occupational dose due to extended plant operation. These projections were compared with the occupational dose limit requirements of 10 CFR Part 20 and with dose levels now being experienced and were also used as the basis for estimates of cancer risk, which were compared with the spontaneous cancer rate.

4.6.3.1 Baseline Occupational Dose

Occupational radiation protection programs in place at nuclear power plants have maintained an annual average individual dose of only 0.28 rem during 1992 (Table 4.10), compared with an exposure limit of 5 rem. Furthermore, the distribution of individual dose (Table 4.11) indicates that only 3 people received doses at the highest reported level of between 4 and 5 rem and less than 0.5 percent of the workers received doses in excess of 2 rem. (Other supportive historical data can be found in Appendix E.)

Table 4.10 Light-water reactor (LWR) occupational whole-body dose data for boiling-water reactors (BWRs) and pressurized-water reactors (PWRs)

Year	Annual average whole-body dose (rem)		
	All LWRs	All BWRs	All PWRs
1973	0.94	0.85	1.00
1974	0.74	0.81	0.68
1975	0.82	0.86	0.76
1976	0.75	0.71	0.79
1977	0.84	0.89	0.65
1978	0.74	0.74	0.65
1979	0.66	0.73	0.56
1980	0.72	0.87	0.52
1981	0.71	0.73	0.61
1982	0.66	0.76	0.53
1983	0.70	0.82	0.56
1984	0.59	0.66	0.49
1985	0.46	0.54	0.41
1986	0.42	0.51	0.37
1987	0.39	0.40	0.38
1988	0.40	0.45	0.36
1989	0.34	0.36	0.33
1990	0.34	0.38	0.31
1991	0.29	0.31	0.27
1992	0.28	0.32	0.26

Source: NUREG-0713.
Note: To convert millirem to millisievert, multiply by 0.01.

Table 4.11 Number of workers at boiling-water reactor (BWRs), pressurized-water reactor (PWRs), and light-water reactor (LWRs) installations who received whole-body doses within specified ranges during 1992

Dose range (rem)	BWRs	PWRs	LWRs
<0.1 (measurable)	17,740	28,220	45,960
0.1–0.25	8,094	12,503	20,597
0.25–0.5	6,883	10,259	17,142
0.5–0.75	3,995	4,926	8,881
0.75–1.00	2,339	2,287	4,626
1.00–2.00	2,366	2,602	5,468
2.00–3.00	204	245	449
3.00–4.00	11	6	17
4.00–5.00	3	0	3
5.00–6.00	0	0	0
6.00–7.00	0	0	0
7.00–12.00	0	0	0
>12.00	0	0	0
Totals	42,095	61,048	103,143

Source: NUREG-0713, 1993.
Note: To convert millirem to millisievert, multiply by 0.01.

As plants age, there will be slight increases in radioactive inventories, resulting in slight increases in occupational radiation doses.

4.6.3.2 Projected Doses for License Renewal

During the license renewal term, the greatest increment to occupational dose over present doses would occur during a 10-year in-service inspection refueling (Table 2.8). The average dose increment related to the 10-year in-service inspection refueling would raise boiling-water reactor averages from a present 360 person-rem (Table 3.12) by 91 person-rem (10-year in-service inspection refueling, Table 2.8) to 451 person-rem and raise pressurized-water reactors from 219 person-rem by 51 person-rem to 270 person-rem. Under the conservative scenario (Table 2.11) these dose increments would add 108 person-rem to BWRs and 66 person-rem to PWRs. These increased levels for a single year are similar to the levels experienced at some plants during the past 2 two reporting years (Table 3.13). After the period of refurbishment, routine operating conditions are expected to cause, industry wide, approximately 32,000 person-rem/year exposure to plant personnel [i.e., 5 percent increase over the currently experienced 30,000 person-mrem/year (Appendix B)]. With the conservative scenario, there is about an 8 percent increase in radiation dose over current operating experience (Tables 2.8 and 2.11).

Within the radiation bioeffects community, one school of thought holds that any radiation exposure is accompanied by a risk of cancer. The other perspective is that below a certain dose and dose rate, no cancer risk is involved. The lowest statistically significant dose associated with excess cancer fatalities among the atomic bomb survivors is considered by ICRP 60 (1991) to be 20 rad. The collective dose to the U.S. population from natural background radiation is approximately 75 million person-rem/year; while not declaring itself on one side or the other on the risk issue, the 1990 BEIR-V report states that there may be no risk from this natural background radiation. If there is no risk from natural background radiation, the annual 32,000 person-rem dose may be of little concern. At the other extreme, if it is assumed that individual doses of less than 20 rem may be included in the collective dose without causing an exaggerated result, the full 32,000 person-rem dose to all workers at nuclear power plants for the typical case may be multiplied by the best estimate risk coefficient for workers (4×10^{-4}); this risk coefficient leads to an annual total of 13 deaths. Of these, 12 would be expected because of normal present-day operation and 1 would be expected to result from aging- and refurbishment-related changes in operation.

This analysis of typically expected conditions provides a range of 0 to 13 deaths induced per year as a result of license renewal, with one of these fatalities resulting from added dose due to aging; very little difference is estimated under the conservative scenario. Thus, radiation doses attributable to plant aging accumulated during the license renewal term might result in a 5 percent increase in the calculated cancer incidence to plant workers, but there may be no increase. The significance of the possible increase depends altogether on the degree of credibility assigned to the risk coefficient derived at high dose and dose rate and applied for low dose and dose rate. In any case, the risk associated with occupational radiation exposures after license renewal is not expected to be significantly different from that during the initial license term.

Currently, occupational radiation doses are on the order of 0.4 rem/year in addition to the 0.36 rem/year received by the typical U.S. resident. If occupational exposure increases by 8 percent as estimated for the conservative scenario, cumulative occupational radiation doses will increase from about 0.76 rem/year to 0.79 rem/year for those working at nuclear plants that operate after the initial license term. Under the typical scenario, occupational doses would increase approximately 5 percent over the currently experienced levels increasing average exposures to 0.78 rem/year.

4.6.3.3 Conclusion

Occupational doses attributable to normal operation during the license renewal term have been examined from several different perspectives. First, projected occupational doses during the period of maximum added dose, the 10-year in-service inspection refueling, are within the range of doses experienced during the past 2 reporting years. Second, the average dose increase of 5 to 8 percent to the typical plant worker would still maintain doses well below regulatory limits. Therefore, occupational radiation exposure during the term of the renewed license meets the standard of small significance. No mitigation measures beyond those implemented during the current term license would be warranted because the ALARA process continues to be effective in reducing radiation doses. This is a Category 1 issue.

4.7 SOCIOECONOMIC IMPACTS

This section reports on the socioeconomic impacts associated with nuclear power plant operations during the license renewal term. The staff reviewed the following socioeconomic issues: (1) changes to local housing caused by plant-induced population growth; (2) the magnitude of all nuclear plant tax payments in relation to total revenues in host communities; (3) disruptions to local public services (i.e., education, transportation, public safety, social services, public utilities, and tourism/recreation); (4) changes to local land use and development patterns resulting from plant-induced population growth and all tax payments; (5) the effects of plant operations on local employment and income levels; (6) plant-related disturbances to historic resources at and around the plant site; and (7) plant-related disturbances to aesthetic resources. Of these socioeconomic impacts only those directly affecting the natural and built environment are carried forward to the decision whether to renew an operating license. The regional economic impact including income, employment, and taxes are not considered in the license renewal decision. As in Chapter 3, plant-induced population growth was studied as a potential influence on a number of the impacts listed above.

The methodological techniques used to evaluate impacts are described briefly in Section 3.7.1 and are detailed in Section C.1; a brief summary of these methods is provided here. For this chapter, past impacts related to plant operations were studied so that the impacts of future operations could be predicted. The impacts projected for the case study sites represent the range of potential impacts at existing nuclear plants because the sample plants were selected to represent the range of nuclear plant sites nationwide. A detailed discussion of site-specific findings is presented in Sections C.4.1 through C.4.7 of Appendix C.

The size of the work force required during the license renewal term is an important determinant of population growth. The permanent license renewal term work force is expected to include those personnel who were on-site during the initial license term, up to 60 additional permanent operations workers per unit, and temporary refueling and maintenance workers during periodic plant outages. Estimates in Chapter 2 and Appendix B of additional work force required during license-renewal-term operations indicate that only one additional worker will be required on a continuous basis for maintenance and inspection activities. The more conservative figure (60 persons per unit) is used in the analysis to account for workers (contractors or rotating utility employees) who are not associated with refueling but may be on-site intermittently. The 60 persons per unit analysis represents an upper bound of the possible socioeconomic impacts.

In addition to those workers previously required during operations-period outages, another 30 workers will be needed for periodic outages during the license renewal term. Potential impacts associated with the presence of periodic outage workers were not systematically evaluated because the duration of these outages will be short (typically 3–4 months). However, evidence about past effects resulting from the temporary influx of refueling/maintenance workers was collected and used in the analysis to predict the impacts of refueling/maintenance during the license renewal term.

The site-specific projections presented here are based on the assumption that no other major construction projects will occur at the same time as refueling and maintenance activities. The potential cumulative population-related impacts during license-renewal-term refueling and maintenance activities would result from the combined populations associated with refueling/maintenance and other concurrent construction activities (not necessarily related to the power plant). Analyses of various refurbishment scenarios (see Appendix C and Chapter 3) suggest the potential magnitude of cumulative impacts resulting from different work force sizes. For example, about 800 refueling/maintenance workers (i.e., about the mean number of workers involved in regularly scheduled outages) combined with another construction work force of about 200, for a total of 1000 workers, would have only small adverse impacts at all but the most remote and sparsely populated sites (e.g., Wolf Creek). Combined work forces of 2,300 could induce large impacts to housing, education, and transportation at some sites. A sensitivity analysis indicates that impact magnitudes would not be increased by a work force as large as 3,400.

The population growth that has resulted from operations at the case study plants has been small, ranging from less than 0.1 percent to 13 percent of a local area's total population (see Table 4.12 and Appendix C). As discussed in Section 3.7.1, the staff believes that Indian Point and Wolf Creek serve as the lower and upper bounds, respectively, of operations-related growth as a percentage of a study area's total population. Thus, population growth that has resulted from worker in-migration is estimated to range at all plants from less than 0.1 percent to 13 percent.

Certain characteristics of the license renewal term work force (e.g., percentage residing in the study area, percentage moving into the study area, percentage of in-migrants accompanied by families) were assumed to be similar to those of the current plant staff and were used to make projections concerning population growth. Information about the impacts that have resulted from population growth during a plant's operation was used to estimate the population-driven impacts that would occur during the plant's license renewal term.

Based on predictions for the case studies, new plant-related population growth resulting from the license renewal term at any nuclear plant would be much smaller than the growth that has resulted from operations thus far. Growth related to increased employment during the license renewal term is expected to represent between less than 0.1 percent and 0.8 percent of the local area's total population for all plants. Because the number of additional permanent workers required at any plant would be relatively small (up to 60 per unit) and because the communities around the plants have already accommodated the existing work force during operations, it is likely that license renewal terms would result in only minimal long-term plant-related population increases for most plants. Therefore, new (incremental) population-driven impacts generally would be minimal, and impacts

Table 4.12 Impact area population growth associated with current and additional permanent plant staff at seven plants in the case study[a]

Plant	Current number of permanent plant staff	Population increase from current staff	Population growth from current staff as a percentage of study area's total population	Projected population increase from additional permanent staff	Population growth from additional staff as a percentage of study area's total population
Arkansas Nuclear One	2205	3418	7.4%	189	0.3%
D. C. Cook					
Bridgman/Lake Township	1252	141	3.0%	15	0.3%
Berrien County		1109	0.7%	104	< 0.1%
Diablo Canyon	1300	2149	1.0%	199	< 0.1%
Indian Point					
Dutchess County	1335	415	0.2%	39	< 0.1%
Westchester County		316	< 0.1%	32	< 0.1%
Oconee	2300	504	0.9%	41	< 0.1%
Three Mile Island	1086	246	1.7%	13	< 0.1%
Wolf Creek	1044	1137	13.3%	68	0.8%

[a]Includes both direct and indirect workers and their families.
Source: Staff computations.

already occurring during current operations would continue with only slight increases during the license renewal term.

4.7.1 Housing

Two types of housing impacts related to workers' demand for housing may occur during license renewal term operations: (1) new housing impacts resulting from the in-migration of additional plant operations workers and (2) the continuing impacts arising from the housing demands of workers involved in periodic plant outages for refueling and maintenance. A third type of impact, unrelated to workers' demands, is the continuing impact of the plant on housing value and marketability.

4.7.1.1 Definition of Significance Levels

Detailed definitions of significance levels of impacts that result from increased housing demand are provided in Section 3.7.2. In summary, small impacts result when no discernible change in housing availability occurs, changes in rental rates and housing values are similar to those occurring statewide, and no housing construction or conversion occurs. Moderate impacts result when there is a discernable reduction in housing availability, rental rates and housing values exceed the inflation rate elsewhere in the state, and minor housing conversions or temporary additions occur. Large impacts occur when project-related demand results in very limited housing availability, considerable increases in rental rates and housing values, and substantial conversion of housing units.

Definitions of the significance of the plant's impacts on the desirability of housing located close to the plant follow. A small impact on housing desirability results when very few or no instances of outmigration occur because of the operation of the nuclear power plant. Also, very few cases of prospective home buyers refusing a home because of its proximity to the plant would occur. Under normal plant operations, housing values should remain within the range of regional fair market prices. Moderate impacts on housing desirability include occasional difficulty in finding a buyer for a house because of its proximity to a nuclear plant. Impacts are also moderate if the proximity of the nuclear plant is cited as a reason for discounting the sale price of the housing units. Impacts on housing desirability are considered large if substantial migration from houses in the vicinity of the plant occurs or if realtors find it difficult or impossible to sell homes in the area. A large impact may also result if a sustained and substantial drop in housing value occurs because of the house's proximity to the plant. Such impacts may be evidenced by a gradual increase in housing value with increasing distance from the plant.

4.7.1.2 Analysis

Housing Demand

The in-migration of plant personnel associated with current operations at each of the seven case study sites has had small impacts on housing. The number of operations workers required at the plants is small relative to original construction work force size, and the operations workers have been introduced gradually to the site so that housing demand has also increased gradually. The demand for housing by refueling workers was found to have a large impact at only one site (Wolf Creek). In that case, approximately 640 additional workers were on-site during the plant outage.

Based on impacts associated with current term operations, population-driven housing impacts resulting from additional permanent workers in the license renewal term would be small at all case study sites. The housing demand resulting from an additional 60 workers per unit would not be large enough to strain the housing markets of communities in which the plants are located and would result in a small impact even in areas where little growth in housing is expected.

Impacts related to the demand for housing resulting from the in-migration of refueling workers are projected to continue to be the same as those currently being experienced—with slight exacerbation due to the additional 30 temporary refueling workers (Section 4.7.1). Thus large impacts may continue at one case study site, Wolf Creek. At other case study plants, these continuing housing impacts associated with in-migrating refueling workers would remain small to moderate.

Housing Marketability

The prevailing belief of realtors and planners in communities surrounding the case study plants is that the plants have had little if any effect on the marketability or value of homes in the vicinity. Housing choices of local residents are rarely affected by the presence of the plant. However, buyers from outside the community are occasionally averse to purchasing properties close to a nuclear power plant. Housing markets have not been affected by this situation because of its infrequency. The value of housing units in close proximity to the plants has experienced only small impacts. A slight negative impact did result because of the accident at Three Mile Island Unit 2; the price of houses in two small subdivisions close to the plant dropped slightly below fair market value after the accident and stayed that way for a brief period following it. At some sites, housing values have increased slightly because of amenities such as sewer systems and improved school systems that were made possible because of tax payments by the nuclear plant.

The license renewal term of the plants will be very much like the original operations period but will include additional safety and maintenance activities. Thus, impacts on housing marketability and values that have occurred during operations will continue during the license renewal term. At all case study sites, only small impacts on housing value and marketability are projected to continue.

4.7.1.3 Conclusion

No demand-related impacts are expected during regular operations, and only small impacts to housing value and marketability are projected. During continuing periodic refueling/maintenance outages, housing demand impacts during refueling/maintenance may range from small to large at various sites. The observed relationship between demographic characteristics and projected housing impacts at the case study sites suggests that large impacts are possible when a work force exceeding 600 persons is required at a site located in a low-population area or in an area that has or recently has had growth control measures that limit housing development. This is a Category 2 issue.

4.7.2 Taxes

This section describes the importance of nuclear plant tax payments as a source of local government revenue. These payments may be made directly to local government jurisdictions or indirectly to local government jurisdictions through state tax and revenue-sharing programs. The tax impacts of operations during the license renewal term were projected based on the current magnitude of tax payments by nuclear plants in relation to total revenues in their local areas (Section C.4.1.3).

4.7.2.1 Definition of Significance Levels

Significance levels during license term renewal operations are considered small if new tax payments are < 10 percent of the taxing jurisdiction's revenue, moderate if payments are 10 to 20 percent, and large if payments represent > 20 percent of revenue. A detailed description of these significance categories is in Section 3.7.3.1. However, the tax payments used to calculate impacts during the license renewal term are all property taxes paid by the nuclear plant, not just the increment due to refurbishment-related improvements.

4.7.2.2 Analysis

The primary taxing authorities for most of the case study plants are the county and city in which the plant is sited and the local school district. The tax-related impacts experienced by those jurisdictions vary widely, depending on the relative size of the taxing jurisdictions and the taxing structure of the state in which the case study is located. The magnitude of current nuclear plant tax payments relative to total local revenues and the associated impact levels is shown in Table 4.13.

The primary tax-related impact expected to occur during the license renewal term at the seven case study plants would be the continuation of tax revenues paid by utilities to local taxing authorities. An additional new tax impact would result from the increase in each plant's assessed value because of refurbishment-based improvements and the associated increase in tax payments. The magnitude of this increase is unknown and may depend on the state's (or other assessing authority's) method of assessment and previous agreements or laws that limit increases in assessed valuation. Generally, the relative importance of tax payments to local jurisdictions during the license renewal term would be similar to that of payments during the current term, although the size of the payments is projected to increase somewhat (see Table 4.13).

4.7.2.3 Conclusion

Tax-related impacts from the continued operation of nuclear plants would range from small to large, as at the case study sites. Tax impacts would consist of the continued effect of direct and indirect tax payments to local jurisdictions, which began before license renewal, in combination with the increase in payments because of refurbishment-related improvements. Impacts of this kind are judged to be beneficial.

4.7.3 Public Services

The approach used to determine past impacts of plant operations and project future public service impacts during the license renewal term is discussed in the introduction to Section 3.7 (also see Section C.4.1.3). For most public services, future impacts were determined based on the projected number of in-migrating workers. To project impacts to local educational systems, however, the number of workers accompanied by their families and the associated family size were also important.

The levels of significance for impacts to public services are the same as those discussed under refurbishment: (1) education, Section 3.7.4.1; (2) transportation, Section 3.7.4.2; (3) public safety, Section 3.7.4.3; (4) social services, Section 3.7.4.4; (5) public utilities, Section 3.7.4.5; and (6) tourism and recreation, Section 3.7.4.6. In general, impacts are small if the existing infrastructure (facilities, programs, and staff) could accommodate any plant-related demand without a noticeable effect on the level of service. Moderate impacts arise when the demand for service or use of the infrastructure is sizeable and would noticeably decrease the level of service or require additional resources to maintain the level of service. Large impacts would result when new programs, upgraded or new facilities, or substantial additional staff are required because of plant-related demand (see Section 3.7.4).

Table 4.13 Current property taxes as percent of total revenues for taxing jurisdiction at seven nuclear power plants in the case study

Plant	Local taxing jurisdiction	Percentage of revenue	Magnitude of beneficial effect
Arkansas Nuclear One	Pope County (study area)	26	Large
	Russellville School District	42	Large
D. C. Cook	Berrien County (study area)	14	Moderate
	Lake Township (study area)	88	Large
	Bridgman School District	81	Large
Diablo Canyon	San Luis Obispo Co. (study area)	11	Moderate
	San Luis Coastal Unified School District	39	Large
Indian Point	Westchester County (study area)	0	Small
	Town of Cortlandt	33	Large
	Hudson School District	37	Large
	Village of Buchannan	49	Large
Oconee	Oconee County (study area)	14	Moderate
	Oconee School District	14	Moderate
Three Mile Island	Londonderry Township (study area)	< 1	Small
	Middletown Borough (study area)	< 1	Small
	Royalton Borough (study area)		
	Lower Dauphin School District	< 1	Small
		< 1	Small
Wolf Creek	Coffey County (study area)	45	Large
	Burlington School District	63	Large

Source: Staff computations.

4.7.3.1 Education

Few if any operations-related impacts on education were found at the case study sites. Communities had no substantial problems assimilating the children of the plant staff into local school systems. Educational impacts during the license renewal term would be small at all case-study sites, as has been the case during past operations. The number of new students would be low relative to the size of current school systems. This small impact could be mitigated by hiring additional staff members for the schools, building new educational facilities, or adding modular classrooms to existing facilities. However, because the impact is so small and implementation of these measures would be costly, such measures would not be warranted.

Based on the case-study analysis, educational impacts are projected to be of small significance at all plants. Because no additional teaching staff or classroom space would be needed, no mitigation measures beyond those implemented during the current term license would be warranted. This is a Category 1 issue.

4.7.3.2 Transportation

Transportation impacts related to current operations have been small at most sites but small to moderate at Three Mile Island and Wolf Creek during refueling and maintenance outages. Impacts to transportation during the license renewal term would be similar to those experienced during current operations and would be driven mainly by the workers involved in current plant operations. The 60 additional permanent workers expected during the license renewal term would represent only a small incremental addition to the continuing impacts from past normal operations, while the 30 incremental workers required during periodic refueling/maintenance outages would represent only a small increase in the number of workers typically involved in periodic outages under the original term of the license.

Based on past and projected impacts at the case study sites, transportation impacts would continue to be of small significance at all sites during operations and would be of small or moderate significance during scheduled refueling and maintenance outages. Because impacts are determined primarily by road conditions existing at the time of the project and cannot be easily forecast, a site specific review will be necessary to determine whether impacts are likely to be small or moderate and whether mitigation measures may be warranted.This is a Category 2 issue.

4.7.3.3 Public Safety

Overall, no serious disruptions of services occurred at the case study sites during the operations period. Existing services were adequate to handle the influx of plant staff. Impacts during license renewal would be largely the same as those that occurred during past operations. There would be little or no need for additional police or fire personnel. For this reason impacts would be of small significance at all sites. This small impact could be mitigated by hiring additional police or fire personnel, purchasing additional fire or police vehicles, building police or fire stations, or making improvements and additions to existing facilities. However, because existing services are projected to be adequate to handle plant-related demands and because mitigative measures would be costly, no mitigation measures beyond those implemented during the current term license would be warranted. This is a Category 1 issue.

4.7.3.4 Social Services

Information from case study sites and the literature support a determination of only small impacts on local social services associated with past operations. Impacts to social services during license renewal would be essentially the same as those that have occurred during past operations and would be of small significance at all sites. These impacts could be mitigated by hiring additional staff to administer existing social service programs or establishing new social service programs. However, because no change in the level of services is anticipated and because mitigative measures would be costly, no mitigation measures beyond those implemented during the current term license would be warranted. This is a Category 1 issue.

4.7.3.5 Public Utilities

Overall, there have been minimal impacts to public utilities as a result of plant operations. The existing capacity of public utilities was sufficient to accommodate the small influx of plant staff, and some locales experienced a noticeable decrease in the level of demand for services with the completion of original plant construction. Although impacts to public utilities during license renewal would be very similar to those that occurred during past operations, an increased problem with water availability may occur in conjunction with plant demand and plant-related population growth as a result of current water shortages in some areas. These shortages may result in moderate impacts to public water supplies at sites with limited water availability. This is a Category 2 issue.

4.7.3.6 Tourism and Recreation

Impacts to recreation and tourism during the license renewal term would be largely the same as those that have occurred during operations in the current term. Few or no adverse effects have occurred during current operations at the case-study sites, and some positive effects have resulted because taxes paid by the plants have allowed some municipalities to improve their recreational facilities and programs. Some plants have also increased local tourism. Based on the case study analysis, it is projected that any adverse impacts would be small at all plants and would primarily be the continuation of impacts of past operations. Some positive impact to tourism and recreation also may continue. These impacts could be mitigated by improving existing recreation facilities or adding recreation areas to meet the expanded demand. Because current facilities would be adequate to accommodate local demand and adding new facilities would be costly, no mitigation measures beyond those implemented during the current term license would be warranted. This is a Category 1 issue.

4.7.4 Off-Site Land Use

This section evaluates the impact of plant-induced changes on local land-use and development patterns produced by plant operation during the license renewal term. Detailed definitions of the three magnitudes of land-use change are provided in Section 3.7.5.1. The magnitude of change to off-site land use is considered small if very little new development and minimal changes to an area's land-use pattern result. Moderate change results if considerable new development and some changes to the land-use pattern occur. The magnitude of change is large if large-scale new development and major changes in the land use pattern occur. During the renewal term, new land-use impacts could result from plant-related population growth or from the use by local governments of the plants' tax payments to provide public services that encourage development. This analysis examines the land-use changes associated with past operations to project the potential new impacts of operations during the license renewal term. Conflicts between off-site land use and nuclear plant operations are not expected because federal regulations (10 CFR Part 54) require each licensee to ensure that its nuclear plant remains appropriately protected from any site-related hazards (e.g., airplanes, toxic gases), new or existing at the time the plant was licensed.

4.7.4.1 Analysis

In most cases, the land-use changes that have resulted from operations at the case study plants have been moderate (see Table 4.14 and Appendix C). However, local property tax payments that the utility makes on its nuclear plants have stimulated large indirect land-use changes in one study area because the local jurisdictions has been able to provide the public services (e.g., sewer and water lines, roads) necessary to support substantial industrial development.

For population-driven land-use impacts, the impact predictors are the same as those discussed for refurbishment (Section 3.7.5). The assessment of new tax-driven land-use impacts considered (1) the size of the plant's tax payments relative to the community's total revenues, (2) the nature of the community's existing land-use pattern, and (3) the extent to which the community already has public services in place to support and guide development. In general, if the plant's tax payments are projected to be small relative to the community's total revenue, new tax-driven land-use changes during the plant's license renewal term would be small, especially where the community has preestablished patterns of development and has provided adequate public services to support and guide development. If the plant's tax payments are projected to be medium to large relative to the community's total revenue, new tax-driven land-use changes would be moderate. This is most likely to be true where the community has no preestablished patterns of development (i.e., land use plans or controls) or has not provided adequate public services to support and guide development in the past, especially infrastructure that would allow industrial development. If the plant's tax payments are projected to be a dominant source of the community's total revenue, new tax-driven land-use changes would be large. This would be especially true where the community has no preestablished pattern of development or has not provided adequate public services to support and guide development in the past.

It is projected that population growth related to worker in-migration in the license renewal term would result in small land-use impacts for all of the socioeconomic case study areas (see Appendix C). In contrast, it is projected that new tax-driven land-use impacts would be large at one case study site and moderate at the others during the license renewal term.

4.7.4.2 Conclusion

Based on predictions for the case study plants, it is projected that all new population-driven land-use changes during the license renewal term at all nuclear plants will be small because population growth caused by license renewal will represent a much smaller percentage of the

Table 4.14 Levels of operations-related land-use change at seven case study sites

Plant	Magnitude
Arkansas Nuclear One	Moderate
D. C. Cook	Moderate
Diablo Canyon	Small
Indian Point	Moderate
Oconee	Moderate
Three Mile Island	Small
Wolf Creek	Large[a]

[a]Change due to tax-related impacts.
Source: The staff.

local area's total population than has operations-related growth. Also, any conflicts between offsite land use and nuclear plant operations are expected to be small. In contrast, it is projected that new *tax-driven* land-use changes may be moderate at a number of sites and large at some others. Because land use changes may be perceived by some community members as adverse and by others as beneficial, the staff is unable to assess generically the potential significance of site-specific off-site land use impacts. This is a Category 2 issue.

4.7.5 Economic Structure

The effects of plant operations during the license renewal term on local employment are predicted by comparing the projected number of direct and indirect jobs created during the license renewal term at a plant with projected total employment for the appropriate study area. Relatively few *new* plant-related jobs would be created during the license renewal term. Nearly all plant-related employment (and associated impacts) expected during that time period would represent a continuation of employment (and impacts) from past operations.

4.7.5.1 Definition of Significance Levels

A detailed explanation of levels of impact significance is in Section 3.7.6.1. Economic effects are small if plant-related employment accounts for <5 percent of total study area employment, moderate if it accounts for 5 to 10 percent, and large if it accounts for more than 10 percent of total study area employment. In summary, the relevant workers are those involved in plant operation, including both new and existing workers. Also, if the magnitude of plant-related employment relative to total study area employment is close to the upper bound for a particular significance level, the impact should be placed in the next higher significance category if the site is remotely located and has a low population density. A site is considered remote if, within a distance of 80 km (50 miles), there is no city with more than 100,000 persons. Low population density is less than 50 persons per 2.6 km^2 (1 square mile). This adjustment factor is necessary to determine the importance of plant employment to the local area in light of its proximity to other areas with competing employment opportunities.

4.7.5.2 Analysis

The economic impacts that have resulted from operating the case study plants range from small to large (see Table 4.15 and Appendix C). Plant-related employment ranges from less than 1 percent to 18 percent of total employment in the communities near the case study plants.

The economic impacts projected to occur during the license renewal term would be primarily a continuation of impacts that already have occurred. At most case study sites, the share of total local employment represented by plant-related employment will be the same as or slightly less than that during current operations (Table 4.15).

4.7.5.3 Conclusion

Based on the findings for the case study sites, economic impacts would be beneficial at all nuclear plant sites. These beneficial impacts would range from small to large.

Table 4.15 Current and projected employment effects of plant operation for the sites in the case study[a]

	Current operations		License renewal term operations	
Plant	Percentage of study area employment[b]	Magnitude of impact	Percentage of study employment[b]	Magnitude of impact
Arkansas Nuclear One	12	Large	8.9	Large
D. C. Cook				
Bridgman/Lake Township	8	Moderate	8.1	Moderate
Berrien Co.	2	Small	1.8	Small
Diablo Canyon	2	Small	1.2	Small
Indian Point	< 1	Small	< 1.0	Small
Oconee	7	Moderate	3.6	Small
Three Mile Island	13	Large	9.8	Large
Wolf Creek	18	Large	7.1	Moderate

[a]Includes the effect of direct *and* indirect jobs and income created by plant operations.
[b]By place of residence.
Source: Appendix C.

4.7.6 Aesthetic Resources

This section evaluates the impacts on aesthetic resources from continued operation during an extended license renewal period. Significance levels of impacts are the same as those described in Section 3.7.8. The analysis of aesthetic impacts focuses on the visibility and perception of the plants' buildings, particularly containment structures and cooling towers and their associated water vapor plumes. These site features are often visible from neighborhoods, roads, and recreation-based water bodies over a wide area. However, no new visual changes are expected during the renewal term, and impacts primarily would be those that currently exist and would change only as the public's perceptions changed or as new information about affected resources arose.

The evaluation of impacts of past power plant operations and projected future impacts on aesthetic resources involved the following: (1) staff examination of local perceptions at the seven case study sites, as reported by key informants; (2) a brief survey of the original and eventually realized aesthetic impacts at other operating nuclear power plants; (3) a survey of relevant academic literature; and (4) a review of recent newspaper and magazine articles related to these issues. In addition, the staff reviewed several final environmental impact statements prepared by NRC for plants located in areas where aesthetic impacts were perceived to be an important issue: the Indian Point Nuclear Power Plant, located in the lower Hudson River Valley in New York (NUREG-0042, NUREG-0574, Jones and Jones 1975); the Greene County Nuclear Plant in the mid-Hudson River Valley (NUREG-0512); the Montague Nuclear Plant, in north Central Massachusetts (NUREG-0084); and Floating Nuclear Plant, an offshore location (NUREG-0394). Finally, the staff reviewed research sponsored by NRC that developed an econometric model for explaining and predicting visual aesthetic impacts.

4.7.6.1 Analysis

Nuclear power plants—particularly those with natural draft cooling towers—stand out starkly from their backgrounds both physically and symbolically. Their containment buildings and, when present, their hyperbolic cooling towers mark these industrial facilities as decidedly different, although their novelty typically appears to wear off for people who view them repeatedly.

Nuclear plants are usually situated in open areas near bodies of water, rendering cooling towers even more visible. Although they are visible from as far away as 10 miles, the structures are typically partially obscured by trees, buildings, or even slight changes in topography. There are few environments where such structures are perceived as well integrated with surrounding landscapes. Additionally, the visible vapor plumes associated with cooling towers can rise more than 5000 ft above the towers and extend as far as 9 miles downwind. Such a presence, although visible only part of the time under certain meteorological and seasonal conditions, extends the plant-related viewshed considerably beyond that of a tower alone.

At Indian Point, opposition to the plant is difficult to separate from opposition to its effect on aesthetic values, which, according to critics, have been diminished by the plant (K. Kennedy; D. Samson; N. Castro; D. Clyde; L. Gobrecht; K. Sauer telephone interviews with James Saulsbury, June 22, 1990). However, based on a viewshed analysis by landscape architects, the plant is either not visible from or is only insignificantly visible from historical sites in the area (Jones and Jones 1975). The plant is visible from the Peekskill Waterfront, from the Stoney Point Marina, from several established areas in Buchanan and Peekskill, and from approaches on the Hudson River (NUREG-0574). Although opposition to a nuclear facility and aesthetic concerns may both be issues in Westchester County, New York, it appears to be far from the situation in South Carolina (Oconee) and Kansas (Wolf Creek). Structures of the D. C. Cook plant (Michigan) and the Diablo Canyon plant (California) are sufficiently hidden or integrated into the existing landscapes that it is difficult to generalize about the public's attitude toward effects on aesthetic resources. The surrounding community seems generally well accustomed to the Arkansas Nuclear One plant in rural Arkansas and has some reservations only about the cooling tower and plume. The 1979 accident at the Three Mile Island plant (Pennsylvania) illustrates how attitudes seem to have directly affected aesthetic preferences (see Appendix C).

From the analysis of the case study plants (summarized in Table 4.16), perceptions of adverse impacts on aesthetic resources from the continued operation of nuclear power plants are probable in limited circumstances. Such circumstances would include areas that have concentrated aesthetic resources within a plant's viewshed or areas where past associations with a plant could diminish one's enjoyment of the physical environment. But even in these circumstances, the staff has not found clear and widespread evidence of adverse consequences to community institutions and functions that would justify characterizing a site as having a large impact.

Among the case study sites, Wolf Creek, Three Mile Island, Oconee, and Diablo Canyon all have had some impacts on prehistoric sites. At Wolf Creek, the presence of the nuclear power plant was credited as a positive force in local preservation efforts because (1) it brought new people into the area, who in turn influenced local citizens regarding the value and benefits that support of historic preservation could bring to a community, and (2) the increased incomes and expanded work force resulted in some neglected structures becoming occupied and repaired (M. Sirico; M. Reams telephone interviews with James Saulsbury, June 22, 1990).

Historic and archaeological resources can vary widely from site to site. Furthermore, they may have been identified only recently (e.g., an archaeological site) or their historic significance only recently established (e.g., a historic building). For these and other reasons, the National Historic Preservation Act of 1966 requires that the agency undertaking a major action consult with the State Historic Preservation Office to determine whether historic resources exist on or near the site and whether they will be affected by the proposed action.

4.7.6.2 Conclusion

The staff believes that the case studies and the other sources of information consulted have bounded the impacts of continued operation of nuclear power plants on aesthetic resources. Under the proposed provisions of license renewal, no applicant is expected to alter the existing visual intrusiveness of any plant. Certainly, the staff expects that some individuals at nuclear plant sites would perceive the plant structures and vapor plumes negatively. These perceptions will be based on purely

Table 4.16 Summary of past and projected impacts on aesthetic resources from operation of seven nuclear power plants in the case study

Impact predictors	Arkansas Nuclear One	D. C. Cook	Diablo Canyon	Indian Point	Oconee	Three Mile Island	Wolf Creek
Plant located near physical or environmental contexts memorialized in popular or professional media	No	No	No	Yes	No	No	No
Plant viewed as decidedly obtrusive into existing landscape	Somewhat	No	No	Yes	No	Yes	No
Active, widely shared, organized opposition to plant's operation because of plant's decided obtrusiveness	None	None	None	None	None	None	None
Measurable socioeconomic impact resulting from decreased aesthetic enjoyment of environment	No	No	No	Limited	No	Limited	No
Significance of past and projected impacts[a]	Insignificant	Insignificant	Insignificant	Moderate	Insignificant	Moderate	Insignificant

[a]Impacts during the license renewal term are expected to be the same as those experienced during past operations unless new information arises or there is a change in the context in which the plant operates.
Source: Appendix C.

aesthetic considerations (for instance, that the plant is out of character or scale with the community), on environmental and safety concerns, or on an anti-nuclear orientation. Whatever the consideration, the staff believes that these individuals' enjoyment of the environment will be depreciated. However, because license renewal will not alter the visual intrusiveness of any plant, the number of individuals having negative perceptions would probably remain constant. The number of such individuals has not been sufficient to measurably impact community institutions and functions in the past, so the staff believes that the impacts on aesthetic resources would be small in the future. For these individuals, mitigation through the use of nonreflective surfaces and tree plantings would be impractical from both efficiency and cost-benefit perspectives; therefore, no mitigation measures beyond those implemented during the current term license would be warranted. The impact on aesthetic resources is a Category 1 issue.

4.7.7 Historic and Archaeological Resources

This section evaluates potential impacts of license renewal term operations to historic and archaeological resources.

4.7.7.1 Definition of Significance Levels

Sites are considered to have small impacts of historic and archaeological resources (1) if the State Historic Preservation Office (SHPO) identifies no significant resources on or near the site, or (2) if the SHPO identifies (or has previously identified) significant historic resources but determines they will not be affected by plant refurbishment, transmission lines, and license-renewal-term operations and there are no complaints from the affected public about altered historic character, and (3) if the conditions associated with moderate impacts do not occur. Moderate impacts may result if historic resources, determined by the SHPO not to be eligible for the National Register, nonetheless are thought by the SHPO or local historians to have local historic value and to contribute substantially to an area's sense of historic character. Sites are considered to have large impacts to historic resources if resources determined by the SHPO to have significant historic or archaeological value would be disturbed or otherwise have their historic character altered through refurbishment activity, installation of new transmission lines, or any other construction (e.g., for waste storage facility). Determinations of significance of impacts are made through consultation with the state historic preservation officer.

4.7.7.2 Analysis

Impacts to historic and archaeological resources during the license-renewal term would be largely the same as those occurring during the current operations period. At the case-study sites, only small impacts are known to occur. However, any construction activity during the license renewal term, such as building a new waste storage facility or a new access road to a transmission corridor, could induce new impacts. Also, it is possible that previously unknown historic and archaeological resources will be identified or their historic significance will be established in the future. As discussed at length in Section 3.7.7, a determination of impact to historic and archaeological resources must be made through consultation with the SHPO as mandated by the National Historic Preservation Act.

4.7.7.3 Conclusions

Although it is unlikely that historic or archaeological impacts of moderate or large significance would occur during the license-renewal term, determinations of impacts to historic and archaeological resources are site-specific in nature and must be made through consultation with the SHPO. Any mitigation measures must likewise be determined on a case-by-case basis. Because site-specific and activity-specific information is needed to assess the significance of impacts to historic and archaeological resources, this is a Category 2 issue.

4.8 GROUNDWATER USE AND QUALITY

4.8.1 Groundwater Use

Those nuclear plants that use groundwater may affect the utility of groundwater to neighbors. This impact could occur as a direct effect of pumping groundwater, thereby either lowering the water table and reducing the availability or inducing infiltration of water of lesser quality into the ground. Neighboring groundwater users could also be affected indirectly if construction or operation of the power plant were to disrupt the normal recharge of the groundwater aquifer. The impact to neighboring groundwater users is likely to be most significant at a site where water resources are limited. Groundwater usage impact may be important at those sites where a power plant's usage rate exceeds 0.0063 m^3/s (100 gpm). Lower usage rates are not expected to impact sole source or other aquifers significantly.

Groundwater is not used at all nuclear power plants, and where it is used, the rate of usage varies greatly among users. Only Grand Gulf uses groundwater as a source of makeup to the condenser cooling system. This largest user employs a Ranney well collection system to draw groundwater from the Mississippi River alluvial aquifer. Other plants use lesser amounts of groundwater for service water systems or for potable water. Some licensed plants intentionally lower the groundwater table, either by pumping or by a system of drains, in the vicinity of building foundations.

The groundwater-use issue was evaluated by examining the groundwater requirements of appropriate subsets of nuclear power plants. Four subsets were established to encompass the entire scope of groundwater-use issues as described above. One subset consists of sites in regions where the water table or artesian water levels historically have been falling for a number of years (Atlantic and Gulf coastal plains, upper Midwest, Arizona, and California). A second subset consists of sites on both high ground and low-lying areas adjacent to the Great Lakes, the Atlantic and Gulf coasts, and the lower Mississippi River where extensive operational dewatering systems may have been installed. A third subset consists of plants with cooling towers adjacent to small rivers. The fourth subset consists of the only plant using groundwater for cooling tower makeup water.

Data were taken from appropriate final safety analysis reports (FSARs) and final environmental statements (FESs) pertaining to operation of nuclear power plants, and sites having potential groundwater-use conflicts were identified. Appropriate state water-use permitting agency representatives and U.S. Geological Survey (USGS) personnel were interviewed by telephone for additional information. Evaluations and conclusions for each of these groundwater-use scenarios are presented separately in the following discussion.

4.8.1.1 Potable and Service Water

Only one of the upper Midwest sites examined withdraws more than 0.0063 m^3/s (100 gal/min) of groundwater for potable and service water systems [Duane Arnold is permitted to withdraw 0.19 m^3/s (3000 gal/min) by the Water Supply Section, Environmental Protection Division, Iowa Department of Natural Resources]. Other plants (Braidwood, Cook, Dresden, Kewaunee, La Salle, Point Beach, and Zion) in the upper Midwest withdraw small amounts 19×10^{-5} to 536×10^{-5} m^3s (3 to 85 gal/min) of groundwater for potable water systems, or none at all. Except for Duane Arnold, all service water systems are supplied by alternative resources (municipal water systems, lakes, or rivers).

Several Atlantic and Gulf coastal plain sites that are not near municipal water suppliers withdraw larger amounts of groundwater than the upper Midwest sites for potable and service water systems. Withdrawals for these sites (Calvert Cliffs, Crystal River, Hope Creek, Salem, and River Bend) range from 0.025 to 0.050 m^3/s (400 to 800 gal/min). Other coastal sites (Turkey Point, St. Lucie, and Waterford) obtain potable and service water from municipal suppliers.

Only one of the two western sites withdraws groundwater for potable and service water systems. The Palo Verde site in Arizona withdraws 0.063 m^3/s (1000 gal/min) from a confined aquifer.

Many plants use groundwater only for potable water systems and require less than 0.0063 m^3/s (100 gal/min). The cones of depression around such wells generally remain within the plant boundary (typically the case for upper Midwest sites). Where the cone of depression does not extend beyond the site boundary, the plant groundwater use is not expected to contribute to cumulative impacts on groundwater supply. For sites having plant wells that produce more than 0.0063 m^3/s (100 gal/min) (sites that draw both service and potable water from wells), cones of depression may extend beyond the plant boundary. For these sites, a reasonable likelihood exists that off-site private wells will be impacted. The staff considers plant contributions to groundwater use to be of small significance where the plant groundwater consumption is less than 0.0063 m^3/s (100 gal/min).

The effect of groundwater usage on neighboring groundwater users will depend on the rate of usage and the distance to the neighboring well. A neighboring well close to the well field of a plant using a large amount of groundwater could experience some decline in yield. The power plants using groundwater are generally remotely located, and groundwater is not thought to be a limited resource. Conflicts that do arise should be resolvable by taking steps to restore yield of the affected water supply, such as deepening the affected wells.

In conclusion, this is a Category 1 issue for those plants using less than 0.0063 m^3/s (100 gal/min) of groundwater for potable and service water. At this usage rate, there would be no significant depletion of the groundwater supply which could impact other users. Because the cone of depression would not extend beyond the site boundary, mitigation is not warranted. However, if use exceeds 0.0063 m^3/s (100 gal/min), there is a possibility of moderate or large adverse effects, and mitigation may be warranted. Therefore, this is a Category 2 issue for those plants using more than 0.0063 m^3/s (100 gal/min) of groundwater.

4.8.1.2 Operational Dewatering Systems

Operational dewatering systems are in place at the Perry site (on a bluff overlooking Lake Erie) and the Calvert Cliffs site (on a bluff overlooking Chesapeake Bay). The Perry site is actively dewatered by pumping wells, and the water table is depressed by more than 15 m (50 ft). During construction dewatering, the cone of depression extended outward about 150 m (500 ft) (it remained inside the site boundary). Less vigorous pumping is required during operational dewatering, and the cone of depression is reduced. If pumping were discontinued, the water table would rise approximately 6 m (20 ft), groundwater would continue to drain passively through a gravity drain system, and the cone of depression would continue to shrink. The Calvert Cliffs site is passively dewatered by an underdrain system (natural gravity flow). The base of the reactor containment structure at Calvert Cliffs is more than 6 m (20 ft) below sea level, whereas the water table is maintained several feet above sea level. There is no impact to neighboring groundwater users at either of these sites.

None of the sites in low-lying areas of the Atlantic coastal plain had operational dewatering systems (i.e., Hope Creek, Millstone, Oyster Creek, St. Lucie, and Turkey Point). At St. Lucie, a construction site dewatering system [pumped at 0.80 m^3/s (13,000 gal/min)] was decommissioned before the plant was placed in operation. The St. Lucie construction/ operation case history is typical of plants in low-lying areas.

For other sites using active dewatering systems (systems in which groundwater is pumped from the aquifer), the same bounding conditions apply as for groundwater use in potable and service water systems. That is, for operational dewatering systems that do not exceed 0.0063 m^3/s (100 gal/min), impacts would be of only small significance. Because the cone of depression would not extend beyond the site boundaries, no mitigation measures beyond those implemented during the current term license would be warranted. For plants that withdraw more than 0.0063 m^3/s (100 gal/min), the significance of the groundwater withdrawal cannot be determined generically. Groundwater use through operational dewatering is a Category 2 issue.

4.8.1.3 Surface Water Withdrawals for Cooling Towers

Many plants located on small rivers have cooling towers. Rivers often supply alluvial aquifers, and large-scale withdrawals of makeup water for evaporative loss could impact an alluvial aquifer during periods of low flow. However, withdrawal from the river is regulated by local or state agencies.

For example, the withdrawal of water at Duane Arnold is restricted at low flow (Water Use Permit). Under normal flow conditions, Duane Arnold withdraws 1.6 m^3/s (27,000 gal/min) from the Cedar River as cooling tower makeup water. This plant continues to operate, at least temporarily, during low flow by withdrawing water from a standby reservoir on a tributary to Cedar River. This reservoir is used only during emergencies when low-flow conditions exist on the Cedar River.

Indirect groundwater-use conflict resulting from surface water withdrawal from a small river for use in cooling towers is a potentially important concern. Because the significance of these conflicts cannot be determined at this time, this is a Category 2 issue.

4.8.1.4 Use of Groundwater for Cooling Tower Makeup

The Ranney wells at Grand Gulf withdraw groundwater from Mississippi River alluvium at a rate of 1.5 m^3/s [24,000 gal/min (34 million gal/day)] for use as cooling tower makeup water to avoid the aquatic effects of a surface water intake. Groundwater in Mississippi River alluvium is used primarily for irrigation and catfish farming (Jamie Crawford, Mississippi Bureau of Land and Water Resources, telephone interview with W. P. Staub, ORNL, Oak Ridge, Tennessee, December 3, 1990). Generally, groundwater from the alluvial aquifer is too high is iron content to be used for municipal water supplies.

The impact of cooling water intake on groundwater at the Grand Gulf plant (the only plant employing Ranney wells) does not conflict with other groundwater uses in the area. However, conflicts could develop if other uses develop (e.g., additional catfish farms). Because it is not possible to predict whether conflicts will occur at Grand Gulf or the significance of impacts associated with Ranney well use at other plants (if they were to adopt their use), it is not possible to determine the significance of Ranney well use at this time. This is a Category 2 issue.

4.8.2 Groundwater Quality

Impairment of groundwater quality could occur at estuary and ocean site facilities that withdraw groundwater for any purpose (e.g., potable and service water systems, operational dewatering). Long-term pumping of groundwater from coastal plain aquifers by industrial and municipal facilities has contributed to saltwater intrusion in some areas of nearly every Atlantic and Gulf Coast state (USGS 1990). The saltwater intrusion issue was evaluated by examining groundwater use at selected nuclear power plants sited on estuaries and oceanic coastlines. Operational dewatering is not taking place at any of the estuaries or coastal sites.

Groundwater quality could also be impaired at inland sites where groundwater may be replaced by poorer quality river water through induced infiltration (NUREG-0777). Potential impairment of groundwater quality at facilities that have large cooling ponds is discussed in Section 4.8.3.

At this time, no licensed plant is located on a sole-source aquifer (i.e., sole or primary source of water supply for an area). If a site occupied by one of the licensed nuclear plants were in an area designated as a sole-source aquifer, NRC would cooperate with responsible agencies in making required information available. Under the provisions of the SDWA, states must establish demonstration programs for protection of critical aquifers.

Slightly elevated concentrations of tritium have been observed in groundwater adjacent to the Prairie Island plant on the Mississippi River in southern Minnesota (Minnesota Environmental Quality Board 1991; Minnesota Department of Public Service 1992). These elevated concentrations have not altered the current use of groundwater near the site. One off-site privately owned well has reported tritium concentrations ranging between 800 and 1000 pCi/L (dates of measurements are uncertain, but they are no more recent than 1991). By comparison, tritium concentrations in North American streams were about 10 pCi/L prior to the beginning of the nuclear age and about 4000 pCi/L at the end of large-scale atmospheric testing of nuclear weapons in 1963. Radioactive decay of tritium between 1963 and 1992 would produce a concentration of about 715 pCi/L (DOE 1992). If tritium concentrations at Prairie Island were as high as 1000 pCi/L in 1992, then perhaps one-third of the tritium contamination found in local groundwater might be attributable to the Prairie Island plant and the balance would be attributable to atmospheric testing. Future radioactive decay of tritium would further reduce its overall concentration in groundwater. Natural decay and tritium release to the environment at Prairie Island might be expected to reach equilibrium eventually at around 300 pCi/L. This compares with a regulatory limit of 20,000 pCi/L in drinking water.

Data were taken from appropriate FSARs and FESs pertaining to the operation of nuclear power plants. Sites having a potential impact on groundwater quality were identified; appropriate state water-use permitting agency representatives and USGS personnel were interviewed by telephone for additional information. Groundwater quality impacts are considered to be of small significance when the plant does not contribute to changes in groundwater quality that would preclude current and future uses of the groundwater. Hence, the contribution of plant operations (during the license renewal period) to the cumulative impacts of major activities on groundwater quality would be relatively small.

4.8.2.1 Potable and Service Water

Groundwater withdrawals in estuary and oceanic areas can cause saltwater intrusion into freshwater aquifers. Saltwater intrusion, where it occurs, is the cumulative effect of groundwater consumption by users in the affected region and therefore could have a cumulative impact on groundwater quality. Estuary and oceanic sites located in rural areas withdraw groundwater from confined aquifers at rates between 0.025 and 0.063 m^3/s (400 and 1000 gal/min) (e.g., for Calvert Cliffs, Crystal River, and Hope Creek–Salem). In contrast, sites located near urban areas purchase water for their potable and service water systems from municipal suppliers (e.g., Millstone, St. Lucie, and Turkey Point), which themselves use groundwater resources. Directly or indirectly, all nuclear power plants in Florida derive their potable and service water supply from groundwater. The staff considers nuclear plant contributions to saltwater intrusion to have small significance on groundwater quality where the plant's groundwater consumption is less than 10 percent of the regional total.

Withdrawal of potable and service water at nuclear power plants represents a small percentage of county-wide water supplies derived from groundwater in both urban and rural counties of Florida. According to Marella (1988, data for 1985), 2.98 and 21.3 m^3/s (68 and 486 million gal/day) of groundwater were withdrawn for all uses in semi-urban St. Lucie and urban Dade Counties where the St. Lucie and Turkey Point plants are located, respectively. Both of these plants purchase about 0.063 m^3/s [1.4 million gal/day (1000 gal/min)] from municipal sources in these counties. About 1.09 m^3/s (25 million gal/day) of groundwater were withdrawn in rural Citrus County, compared with

1.4 million gal/day withdrawn by Crystal River plant wells in that county. Nuclear plant groundwater consumption at its current rate would not contribute significantly to any future saltwater intrusion that might occur.

Ken Miller (Maryland Water Resources Administration, Water Rights Division, telephone interview with W. P. Staub, ORNL, Oak Ridge, Tennessee, November 28, 1990) believes that saltwater intrusion of the Aquia aquifer, which serves the Calvert Cliffs plant, is unlikely. He bases his conclusion on the fact that this aquifer is confined and changes to an aquitard on its downdip (seaward) side as illustrated in USGS (1988) and Chapelle and Drummond (1983).

Geologic conditions as described above are site specific. The USGS (1988) states that the Raritan-Magothy aquifer in New Jersey is susceptible to saltwater intrusion and is already contaminated in some places. However, based on data for Florida, power plant groundwater consumption ranges from about 0.3 percent to 6 percent of the total in urban and rural regions, respectively. Saltwater intrusion is more likely to occur in urban regions because of the greater demand for water, and electric power generation would be a small contributor.

The potential for inducing saltwater intrusion is considered to be of small significance at all sites because groundwater consumption from confined aquifers for potable and service water uses by nuclear power plants is a small fraction of groundwater use in all cases. Where saltwater intrusion has been a problem, the large uses have been agricultural (irrigation) and municipal groundwater consumption. Mitigation for saltwater intrusion, if needed, would likely take the form of groundwater withdrawal curtailments. Because nuclear plant water consumption represents a small fraction of total consumption, consumption curtailments of large groundwater users (i.e., municipal or agricultural users) are more likely. Consequently, groundwater use curtailments are not expected to be warranted for nuclear plants to mitigate saltwater intrusion impacts. However, even if pro-rata curtailments of groundwater consumption were required of all users, nuclear plants could accommodate most conceivable reductions without adversely affecting their operations. Therefore, this is a Category 1 issue.

4.8.2.2 Groundwater Withdrawal at Inland Sites

Grand Gulf uses large quantities of groundwater from an alluvial aquifer as described in Section 4.8.1.4. Geohydrologic modeling has predicted that groundwater would be replaced by river water of lesser quality by induced infiltration (NUREG-0777). A groundwater monitoring system is currently being installed at Grand Gulf, but no data are currently available to validate the model. Nevertheless, the model's prediction is reasonable.

The net flow of the infiltrating river water will be into the Grand Gulf Ranney well collectors. Thus, water quality change will be largely confined to the plant. Any other users of groundwater from the same formation would induce infiltration in a similar manner. The quality of Mississippi River water would not preclude the current uses of the groundwater from the alluvium. Long-term use of Ranney wells may cause groundwater quality to approach the water quality of the adjoining river. Therefore, the change in water quality resulting from use of Ranney wells would be of small significance at any site. The only possible mitigation for a plant using Ranney wells would be to construct and operate a water intake structure in the nearby water body. However, because the change in groundwater quality would not preclude current and future uses and because building a surface water intake structure would be costly and have adverse environmental effects of its own (Sect. 4.8.1.4), no mitigation measures beyond those implemented during the current term license would be warranted. This is a Category 1 issue. Because groundwater quality level would never be lower than that of the nearby Mississippi River, groundwater withdrawal for Grand Gulf's use would not contribute significantly to the cumulative impacts of water infiltration into the aquifer.

4.8.3 Groundwater Quality Impacts of Cooling Ponds

Alteration of groundwater quality in shallow, unconfined aquifers may occur at the nine nuclear power plant sites that use cooling ponds (Section 4.4.1). Irrigation and private domestic water supplies are the principal off-site uses of these groundwater resources. This issue was evaluated by examining off-site land uses and potential for shallow groundwater utilization at all nine sites. The impact on private uses of groundwater was subdivided into two sets based on current land use: (1) sites surrounded by undeveloped land, including saltwater marshes, and (2) sites adjacent to farmland. Short- and long-term potential for utilization of shallow groundwater resources depends on current land use.

Four plant sites are surrounded by undeveloped land or have large exclusion areas around them. These plants are Clinton (large exclusion area), Dresden (surrounded by undeveloped woodlands), South Texas, and Turkey Point (surrounded by saltwater marshes). Although off-site groundwater is not being used currently near these sites, its long-term use is not necessarily precluded.

The remaining five sites have relatively small exclusion areas and are adjacent to farmland. These plants are Braidwood, La Salle, Robinson, Summer, and Wolf Creek. A limited amount of off-site groundwater is being used currently or could potentially be used at these sites in the near term.

All of the cooling ponds are unlined and have surface areas that range from 637 to 2960 ha (1573 to 7310 acres). Cooling pond water has higher concentrations (than makeup water) of total dissolved solids due to evaporation, heavy metals due to contact of cooling water with plant equipment, and chlorinated organic compounds used to prevent biofouling of equipment. The average concentration of total dissolved solids in continuously recycled cooling pond water is about 2.8 times as large as that in makeup water.

Water seeping from these ponds commingles with underlying shallow groundwater and produces a groundwater mound. Groundwater spreads laterally away from this mound. The commingled groundwater will eventually reach off-site areas. At this point, groundwater quality will be between that of the cooling pond water and the quality of the naturally occurring groundwater. These groundwater contaminant plumes are not expected to alter current groundwater-use categories (as defined by various state regulatory agencies) because contaminant concentrations are not expected to rise significantly. However, groundwater quality is not routinely monitored for contaminants specific to cooling ponds.

Depending on groundwater velocity and adsorption characteristics, some contaminants (diluted by dispersion in natural groundwater) may reach off-site areas during the initial term of the license. As plant operation continues, groundwater quality at points near the site may approach the quality of the cooling pond water. If necessary, mitigation of groundwater contamination due to cooling pond operations might take the form of lining the ponds to reduce infiltration or cleaning groundwater by pumping and treating, both of which would be costly.

The extent of groundwater contamination by cooling ponds has not been documented at this time. Off-site groundwater monitoring is not standard practice at these sites, and there are no data with which to characterize the significance of potential off-site groundwater contamination. For those plants with cooling ponds located in a salt marsh (South Texas and Turkey Point), groundwater quality is not a significant concern because groundwater quality beneath salt marshes is too poor for human use. Because continued infiltration into the shallow aquifer will not change its groundwater use category (which is already restricted to industrial uses only) and because potential mitigation measures would be costly, no mitigation measures beyond those implemented during the current term license would be warranted. Therefore, for plants with cooling ponds located in salt marshes, this is a Category 1 issue. Groundwater in salt marshes is already restricted to industrial use, and there is no mechanism by which cooling pond water infiltrating into the groundwater would change its use category. The impact on groundwater quality for plants with cooling ponds that are not located in salt marshes is a Category 2 issue.

4.9 SUMMARY OF IMPACTS OF OPERATION

The conclusions about the environmental impacts of nuclear power plant operation during a license renewal term are summarized below.

Threatened and Endangered Species

- It is not possible to reach a conclusion about the significance of potential impacts to threatened and endangered species at this time because (1) the significance of impacts on such species cannot be assessed without site- and project-specific information that will not be available until the time of license renewal and (2) additional species that are threatened with extinction and that may be adversely affected by plant operations may be identified between the present and the time of license renewal. This is a Category 2 issue.

Surface Water Quality, Hydrology, and Use

- The staff examined nine aspects of water quality that might be affected by power plant operations: current patterns at intake and discharge structures, salinity gradients, temperature effects on sediment transport, altered thermal stratification of lakes, scouring from discharged cooling water, eutrophication, discharge of biocides, discharge of other chemical contaminants (e.g., metals), and discharge of sanitary wastes. Open-cycle cooling systems are more likely than other cooling systems to have such effects because they withdraw and discharge very large volumes of water; however, the impacts for each of these effects were found to be of small significance for all plants, regardless of cooling system type. For each type of impact, the staff considered potential mitigation measures but found that none were warranted because they would be costly and would have very small environmental benefits. These are Category 1 issues.

- The staff found no potential for water use conflicts or riperian plant and animal community impacts of moderate or large significance for plants with open-cycle cooling systems because they are used on large water bodies. Because the potential mitigation measures are costly and because the potential benefits are small, the staff does not consider mitigation to be warranted. These are Category 1 issues.
- The staff found that water use conflicts and the effects of consumptive water use on in-stream aquatic and riparian terrestrial communities could be of moderate significance at some plants that employ cooling-tower or cooling-pond systems because they are often located near smaller water bodies. For plants with these cooling systems, these are Category 2 issues.

Aquatic Ecology

- The staff examined 12 potential effects that nuclear power plant cooling systems may have on aquatic ecology: (1) impingement of fish; (2) entrainment of fish (early life stages); (3) entrainment of phytoplankton and zooplankton; (4) thermal discharge effects; (5) cold shock; (6) thermal plume barriers to migrating fish; (7) premature emergence of aquatic insects; (8) stimulation of nuisance organisms; (9) losses from predation, parasitism, and disease among organisms exposed to sublethal stresses; (10) gas supersaturation; (11) low dissolved oxygen in the discharge; and (12) accumulation of contaminants in sediments or biota. Except for three potential impacts (entrainment of fish and shellfish, impingement of fish and shellfish, and thermal discharge effects), each of these was found to be of small significance at all plants. Because mitigation would be costly and provide little environmental benefit, no additional mitigation measures beyond those implemented during the current license term are warranted. These are Category 1 issues. The other three impacts would be of small significance at all plants employing cooling-tower cooling systems. Because mitigation would be costly and provide little environmental benefit, no additional mitigation measures beyond those implemented during the current license term are warranted. For those plants, these are Category 1 issues. However, the impacts may be of greater significance at some plants employing open-cycle or cooling-pond systems; and these are Category 2 issues for those plants.

Groundwater Use and Quality

- The staff found that groundwater use of less than 100 gal/min is of small significance because the cone of depression will not extend beyond the site boundary. Conflicts might result from several types of groundwater use by nuclear power plants. If groundwater conflicts arose, they could be resolvable by deepening the affected wells, but no such mitigation is warranted because sites producing less than 0.0063 m^3/s (100 gal/min) would not have a cone of depression that extends beyond the site boundary. This is a Category 1 issue. Plants that extract more than 0.0063 m^3/s (100 gal/min), including plants using Ranney wells, may have groundwater use conflicts of moderate or large significance. Groundwater use is a Category 2 issue for such plants.

- Cooling system makeup water consumption may cause groundwater use conflicts. During times of low flow, surface water withdrawals for cooling tower makeup from small rivers can reduce groundwater recharge. Because the significance of such impacts cannot be determined generically, this is a Category 2 issue.
- Groundwater withdrawals could cause adverse effects on groundwater quality by inducing intrusion of lower-quality groundwater into the aquifer. The staff found that the significance of these potential impacts are of small significance in all cases. Because all plants except Grand Gulf use relatively small quantities of groundwater and surface water intrusion at Grand Gulf would not preclude current water uses, the staff found that mitigation was not warranted. This is a Category 1 issue.
- Cooling ponds leak an undetermined quantity of water through the pond bottom. Because the water in cooling ponds is elevated in salts and metals, such leakage may contaminate groundwater. The staff found that groundwater quality impacts of ponds located in salt marshes would be of small significance in all cases because salt marshes already have poor water quality. This is a Category 1 issue. Cooling ponds that are not located in salt marshes may have groundwater quality impacts of small, moderate, or large significance. This is a Category 2 issue.

Air Quality

- Small amounts of ozone and substantially smaller amounts of oxides of nitrogen are produced by transmission lines; however, ozone concentrations generated by transmission lines are too low to cause any significant effects. The minute amounts of oxides of nitrogen produced are also insignificant. Thus, air quality impacts associated with the operational transmission lines during the renewal term are expected to be of small significance at all sites. Potential mitigation measures would be very costly and are not warranted. This is a Category 1 issue.

Terrestrial Ecology

- The potential impact of cooling tower drift on crops and ornamental vegetation arising from operations during the license renewal term is expected to be of small significance for all nuclear plants. No mitigation measures beyond those implemented during the current license term are warranted because there have been no measurable effects on crops or ornamental vegetation from cooling tower drift. This is a Category 1 issue.
- The impact of cooling towers on natural plant communities would continue to be unmeasurable as a result of license renewal and will therefore be of small significance. Because the impacts of cooling tower drift on native plants are expected to be small and because potential mitigation measures would be costly, no mitigation measures beyond those during the current term license would be warranted. This is a Category 1 issue.

- Bird mortality from collision with power lines associated with nuclear plants is of small significance for all plants because bird mortality is expected to remain a small fraction of total collision mortality associated with all types of man-made objects. Because the numbers of birds killed from collision with cooling towers are not large enough to affect population stability or the ecosystem, consideration of further mitigation is not warranted. Both bird collosion with power lines and bird collision with cooling towers are Category 1 issues.
- Because no threat to the stability of local wildlife populations or vegetation communities is found for any cooling pond, the impacts are found to be of small significance. Potential mitigation measures would include excluding wildlife (e.g., birds) from contaminated ponds, converting to a dry cooling system, or reducing plant output during fogging or icing conditions. The impacts are found to be so minor that consideration of additional mitigation measures is not warranted. These effects of cooling ponds are so minor and so localized that cumulative impacts are not a concern. This is a Category 1 issue.
- Maintaining power-line ROWs causes fluctuations in wildlife populations, but the long-term effects are of small significance. The staff found that bird collision with transmission lines are of small significance. Also, transmission line maintenance and repair would have impacts of only small significance on floodplains and wetlands. In each case, the staff found that potential mitigation measures beyond those implemented during the current license term would be costly and provide little environmental benefit, and thus are not warranted. These are Category 1 issues.
- Wildlife, livestock, and plants residing in power-line EMF apparently grow, survive, and reproduce as well as expected in the absence of EMF. The potential impact of EMF on terrestrial resources during the license renewal term is considered to be of small significance for all plants. Because the impact is of small significance and because mitigation measures could create additional environmental impacts and would be costly, no mitigation measures beyond those implemented during the current term license would be warranted. This is a Category 1 issue.

Land Use

- Land use restrictions are necessary within transmission-line ROWs. The staff found these impacts to be of small significance at all sites. Mitigation beyond that imposed when ROWs were established might include relocating the transmission line. The staff concluded that such mitigation would not be warranted because it would be very costly and provide little environmental benefit. This is a Category 1 issue.

Human Health

- During the license renewal term, the radiation dose commitment to the total worker population is projected to increase less than 5 percent at nuclear power plants under the typical scenario and less than 8 percent at any plant under the conservative scenario. The present operating experience results in about 30,000 person-rem/year for all licensed plants combined. After refurbishment, routine operating conditions are expected to result in 32,000 person-rem/year for all plants combined. The risk associated with occupational radiation exposures after license renewal is expected to be of small significance at all plants. No mitigation measures beyond those implemented during the current license term are warranted because the existing ALARA process continues to be effective in reducing radiation doses. This is a Category 1 issue.

- Among the 150 million people who live within 50 miles of a U.S. nuclear power plant, about 30 million will die of spontaneous cancer unrelated to radiation exposure from nuclear power plants. This number is compared with approximately 5 calculated fatalities associated with potential nuclear-power-plant-induced cancer. The estimated annual cancer risk to the average individual is less than 1×10^{-6}. Public exposure to radiation during the license renewal term is of small significance at all sites, and no mitigation measures beyond those implemented during the current license term are warranted because current mitigation practices have resulted in declining public radiation doses and are expected to continue to do so. This is a Category 1 issue.
- The significance of potential for electrical shock from charges induced by transmission lines that may occur during the license renewal term cannot be evaluated generically because no NESC review was performed for some of the earlier licensed plants. For those that underwent an NESC review, a change in the transmission line voltage may have been made since issuance of the initial operating license, or changes in land use since issuance of the original license could have occurred. This is a Category 2 issue.
- There is no consensus among scientists on whether 60-Hz electromagnetic fields have a measurable human health impact. Because of inconclusive scientific evidence, the chronic effects of electromagnetic fields would be not be categorized as either a Category 1 or 2 issue. If NRC finds that a consensus has been reached that there are adverse health effects, all license renewal applicants will have to address it in the license renewal process.
- Occupational health questions related to thermophilic organisms, like *Legionella* sp., are currently resolved using proven industrial hygiene principles to minimize worker exposures to these organisms in mists of cooling towers. Adverse occupational health effects associated with microorganisms are expected to be of small significance at all sites. Aside from continued application of accepted industrial hygiene procedures, no additional mitigation measures beyond those implemented during the current license term are warranted. This is a Category 1 issue.
- Thermophilic organisms may or may not be influenced by operation of nuclear power plants. The issue is largely unstudied. However, NRC recognizes a potential health problem stemming from heated effluents. Public health questions require additional consideration for the 25 plants using cooling ponds, lakes, canals, or small rivers because the operation of these plants may significantly enhance the presence of thermophilic organisms. The data for these sites is not now at hand and it is impossible with current knowledge to predict the level of thermophilic organism enhancement at any given

site. Thus, the impacts are not known and are site specific. Therefore, the magnitude of the potential public health impacts associated with thermal enhancement of *N. fowleri* cannot be determined generically. This is a Category 2 issue.

Noise

- The principal noise sources at power plants (cooling towers and transformers) do not appreciably change during the aging process. Because noise impacts have been found to be small and generally not noticed by the public, noise impacts are expected to be of small significance at all sites. Because noise reduction methods would be costly, and given that there have been few complaints, no additional mitigation measures are warranted for license renewal. This is a Category 1 issue.

Socioeconomics

- The staff examined socioeconomic effects of nuclear power plant operations during a license renewal period. Five of these would be of small significance at all sites: education, public safety, social services, recreation and tourism, and aesthetics. Because mitigation measures beyond those implemented during the current license term are costly and would offer little benefit, no additional mitigation measures are warranted. These are Category 1 issues. Four of the socioeconomic effects were found to have moderate or large significance at some sites: housing, transportation, public utilities (especially water supply), and off-site land use. These are Category 2 issues. In addition the statutory requirement (National Historic Preservation Act) requires consultation; thus historic and archaeological resources are Category 2 issues.

4.10 ENDNOTES

1. For example, Coleman et al. 1989; Fulton et al. 1980; Savitz et al. 1988; Spitz and Johnson 1985; Tomenius 1986; Wertheimer and Leeper 1979; Wilkins and Koutras 1988; Feychting and Ahlbom 1993; Petridow et al. 1993.
2. Anthony and Morrison 1985; Beason et al. 1982; Bunyan and Stanley 1983; Campbell et al. 1983; Castrale 1987; Wildlife No. 235; Connor and McMillan 1988; D'Anieri et al. 1987; DeFazio et al. 1988; de Waal Malefyt 1987; Freedman et al. 1988; FWS/OBS-79/22; Gangstad and Hesser 1989; Gangstad and Phillips 1989; Ghassemi and Quinlivan 1982; Hill and Camardese 1986; Hoffman and Albers 1984; Hoffman et al. 1990; Holechek 1981; Hudson et al. 1984; Kennedy and Jordan 1985; Kirkland 1978; Lautenschlager 1986; Linder and Richman 1990; Lochmiller et al. 1991; Mayer 1976; McComb and Rumsey 1982, 1983a, 1983b; Moore 1983; Morrison and Meslow 1984a, 1984b; Newton and Knight 1981; Rands 1986; Risebrough 1986; Roberts and Dorough 1984; Santillo et al., 1989a, 1989b; Savidge 1978; Schulz et al. 1992a, 1992b; Solberg and Higgins 1993; Steele 1984; Sullivan and Sullivan 1981, 1982; Thompson et al. 1991; Voorhees 1984; Walker 1983; Warren et al. 1984; White et al. 1981.
3. Anthony and Morrison 1985; Beason et al. 1988; Bunyan and Stanley 1983; Lautenschlager 1986; McComb and Rumsey 1983a; Moore 1983; Morrison

and Meslow 1984a, 1984b; Rands 1986; Risebrough 1986; Solberg and Higgins 1993.

4. Anderson 1979; Betsill et al. 1981; Bramwell and Bider 1981; Denoncour and Olson 1984; Eaton and Gates 1981; Everett et al. 1981; Geibert 1980; Kroodsma 1984c; Meyers and Provost 1981; Morhardt et al. 1984; Niemi and Hanowski 1984; Schreiber et al. 1976.
5. Anderson 1978; Beaulaurier et al. 1984; Brown et al. 1985; Crawford 1981; Faanes 1987; Fredrickson 1983; Howard et al. 1985; Krapu 1974; ORAU-142, 1978c; Malcolm 1982; Mathiasson 1993; Meyer and Lee 1981; Rusz et al. 1986.
6. Bohm 1988; Bridges and McConnon 1987; Denoncour and Olson 1984; Fitzner 1980; Gilmer and Stewart 1983; Knight and Kawashima 1993; Lee 1990; Paton and Kneedy 1993; Postovit and Postovit 1987; Roppe et al. 1989; Smith 1985; Stahlecker 1978; Steenhof et al. 1993; Williams and Colson 1989.
7. A discussion of the International System units used in measuring radioactivity and radiation dose is given in Appendix E, Section E.A.3.

4.11 REFERENCES

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7. DECOMMISSIONING

7.1 INTRODUCTION

Decommissioning is defined as the safe removal of a nuclear facility from service and the reduction of residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license (10 CFR Part 50.82). Decommissioning must occur because a licensee is not permitted to abandon a facility after ceasing operation. Decommissioning activities do not include the removal of spent fuel, which is considered to be an operational activity; the storage of spent fuel, which is addressed in the Waste Confidence Rule (10 CFR Part 51.23); or the removal and disposal of nonradioactive structures and materials beyond that necessary to terminate the U.S. Nuclear Regulatory Commission (NRC) license. Disposal of the nonradioactive hazardous waste that is not necessary for NRC license termination is not considered part of the decommissioning process for which NRC is responsible.

The purpose of this chapter is to determine whether license renewal of nuclear power plants would change the impacts of decommissioning to such an extent that those impacts would need to be assessed and mitigative measures considered as part of the environmental review for license renewal. Current licenses allow nuclear power plants to operate for as long as 40 years. License renewal would extend the period of operation by as much as 20 years. This chapter addresses incremental impacts of decommissioning after a 20-year license renewal compared with operating for 40 years.

The following potential impacts are addressed: radiation exposures to workers and the public, socioeconomic effects, waste management impacts, air and water quality impacts, and ecological impacts. The principal impacts of decommissioning are expected to result from radiation exposures to workers and from disposal of radioactive materials. Decommissioning is expected to have only minor radiological impacts on the public (primarily as a result of transporting radioactive waste). Socioeconomic impacts of decommissioning would result from the demands on, and contributions to, the community by the workers employed to decommission a power plant. As shown in this chapter, the air quality, water quality, and ecological impacts of decommissioning are all expected to be substantially smaller than those of power plant construction or operation because the level of activity and the releases to the environment are all expected to be smaller during decommissioning than during construction and operation. The effect of license renewal on the costs of decommissioning are also examined because the costs of decommissioning continues to be a public concern; however, no category conclusion is reached because the impact of license renewal on decommissioning cost is not a consideration in the environmental review and the decision to renew a license.

The impacts resulting from decommissioning at 40 years (baseline) are taken from NUREG-0586, the two source documents NUREG/CR-0130 and NUREG/CR-0672, and updates to those source documents such as draft reports NUREG/CR-5884 and NUREG/CR-6174. The same methods used in those documents were used to project the impacts of decommissioning after 60 years of operation. Where the source documents did not address a potential impact, other available data and staff members' professional judgments were used to assess the potential for impacts to change as a result of extended operation. The analysis in this chapter is based on large "reference" pressurized-water reactor (PWR) and boiling-water reactor (BWR) nuclear power plants; consequently, the impacts of decommissioning all U.S. nuclear power plants that reach the end of their operating lives without a serious accident should be encompassed by those described here. The changes in impacts resulting from the extended operation and in the environment at the time of decommissioning were considered. [The discussion is built around a "reference" PWR identified by NUREG/CR-0130, the 1175-MW Trojan Nuclear Plant at Rainier, Oregon, and a "reference" BWR, the 1155-MW(e) Washington Public Power Supply System Nuclear Project 2, which was being built near Richland, Washington (NUREG/CR-0672).]

7.2 THE DECOMMISSIONING PROCESS

This section describes the locations of radioactive materials in nuclear power plants, notes the three commonly discussed decommissioning methods, summarizes experience to date with decommissioning nuclear power plants, and provides information on the wastes generated during decommissioning. Except as noted, the information for this section is from NUREG-0586.

7.2.1 Nuclear Power Plants

Nuclear power plants in the United States use two types of nuclear reactors (Chapter 2); the most common type is the PWR. Most of the 118 licensed power reactors in the United States are PWRs. The other type is the BWR. The locations of radioactive components in these two types of power plants are described briefly to aid the reader's understanding of decommissioning.

7.2.1.1 Pressurized-Water Reactors

Buildings or structures associated with a typical large PWR (Figure 7.1) include (1) the heavily reinforced concrete containment building, which houses the pressure vessel, the steam generators, and the pressurizer system; (2) the turbine building, which contains the turbines and the generator; (3) the cooling water system, which may include the cooling tower and other components; (4) the fuel building, which contains fresh and spent fuel, fuel handling facilities, the spent-fuel storage pool and its cooling system, and the solid radioactive waste system; (5) the auxiliary building, which contains the liquid radioactive waste treatment systems, the filter and ion exchanger vaults, the gaseous radioactive waste treatment system, and the ventilation systems for the containment, fuel, and auxiliary buildings; (6) the control building, which houses the reactor control room and personnel facilities; (7) water intake structures; (8) the administration building; and (9) other structures such as warehouses and nonradioactive shops.

The major radioactive components encountered in decommissioning are associated with the reactor itself—the primary coolant loop, the steam generators, the radioactive waste handling systems, and the concrete biological shield that surrounds the pressure vessel. The reactor core, pressure vessel, steam generators, and piping between the reactor and steam generators are highly radioactive. Because some primary-to-secondary leakage is

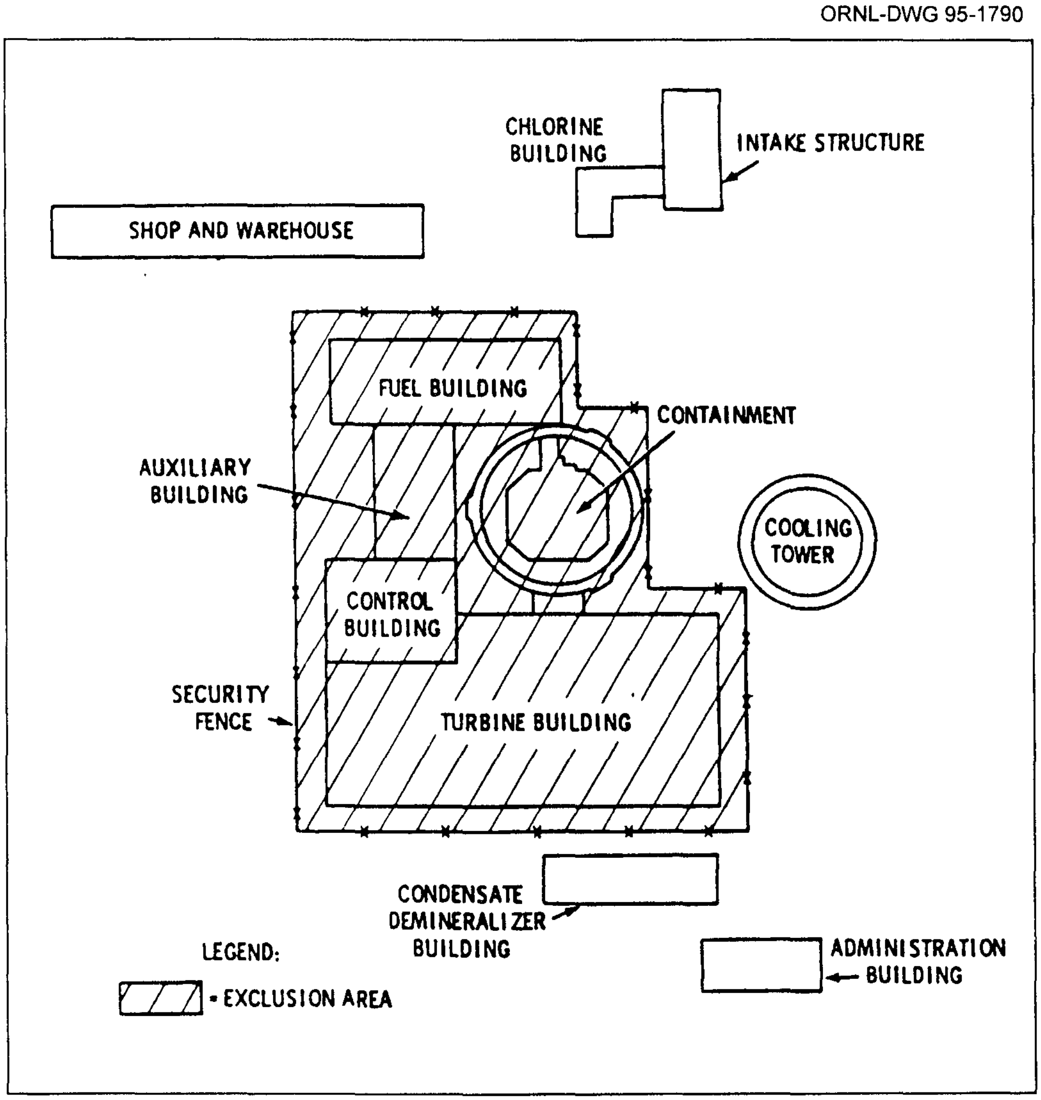

Figure 7.1 Typical pressurized-water reactor generating station layout. Adapted from NUREG/CR-0130.

impossible to avoid, the secondary loop, including the turbines, is slightly contaminated. Because of leakage and blowdown, the cooling water is very slightly contaminated. Much equipment in the auxiliary building is contaminated, as is the spent-fuel storage pool and its associated equipment.

7.2.1.2 Boiling-Water Reactors

Buildings and structures associated with a typical large BWR (Figure 7.2) include (1) the reactor building, which houses the reactor pressure vessel, the containment structure, the biological shield, the spent-fuel pool, and fuel handling equipment; (2) the turbine building, which houses the

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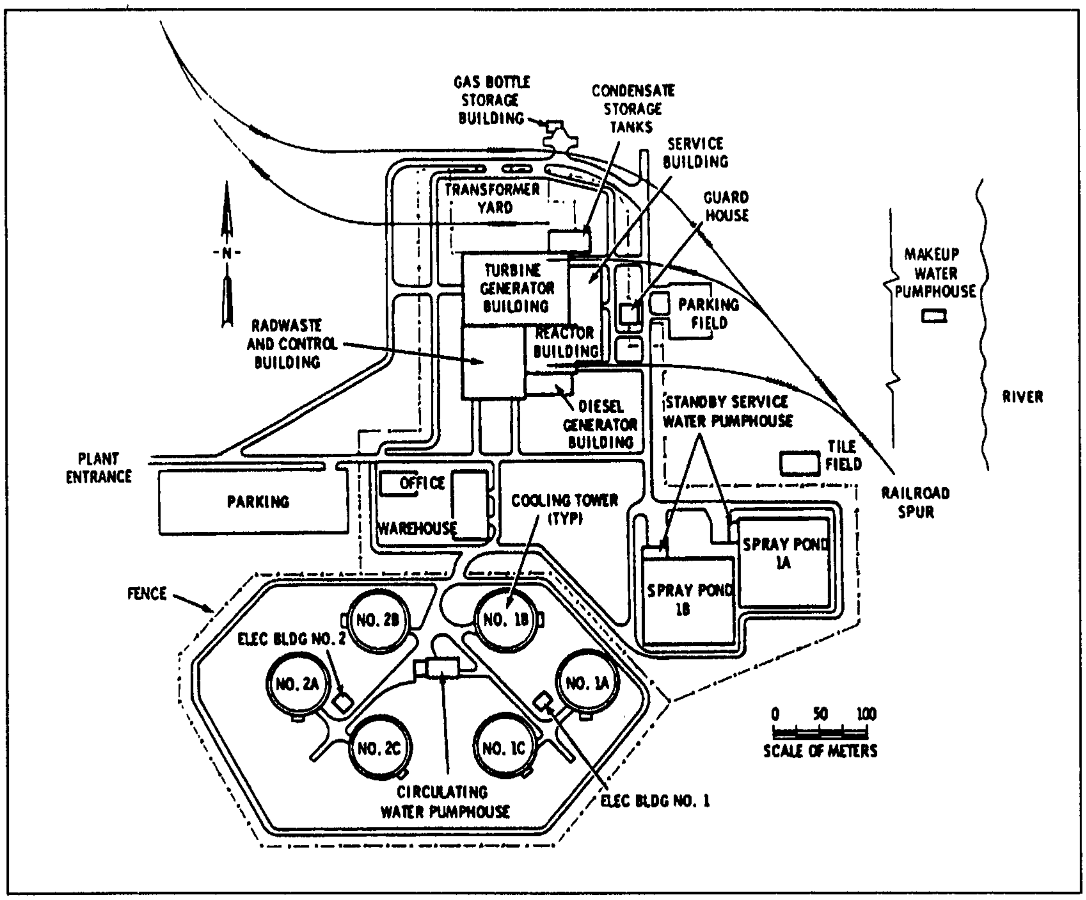

Figure 7.2 Site layout on a typical boiling-water reactor power plant. Adapted from NUREG-0672.

turbine and electric generator; (3) the radioactive waste and control building, which houses the solid, liquid, and gaseous radioactive waste treatment systems and the main control room; (4) the cooling system; (5) water intake structures and pump houses; (6) the service building, which houses the makeup water treatment system, machine shops, and offices; and (7) other minor structures.

The major sources of radiation in decommissioning a BWR are associated with the reactor itself, the containment structure, the concrete biological shield, the primary coolant loop, the turbines, and the radioactive waste handling systems. The reactor building, the turbine generator building, and the radioactive waste building are the only buildings containing radioactive materials. The reactor core and its pressure vessel are highly contaminated, as is the piping to the turbines. The turbines are also contaminated, but the cooling towers and associated piping are not. Much equipment in the radioactive waste building is contaminated, as is the spent-fuel pool in the reactor building.

7.2.2 Decommissioning Methods

In the NRC's original decommissioning studies (NUREG/CR-0130 for PWRs and NUREG/CR-0672 for BWRs), three alternatives were defined: DECON (decontamination/dismantlement as rapidly after reactor shutdown as possible to achieve termination of the nuclear license); SAFSTOR (a period of safe storage of the stabilized and defueled facility followed by final decontamination/dismantlement and license termination); and ENTOMB (immediate removal of the highly activated reactor vessel internals for disposal and relocation of the remainder of the radioactively contaminated materials to the reactor containment building, which is then sealed. With sufficient time, the radioactivity on the entombed materials will have decayed to levels that permit termination of the nuclear license). However, because current regulations require decommissioning to be complete within 60 years, ENTOMB may not be a viable option.

Changes in the industrial and regulatory situation in the United States since the late 1970s have forced revisions to the scenarios of the NRC's original decommissioning alternatives. The most recently revised decommissioning scenarios are described for PWRs in NUREG/CR-5884 and for BWRs in NUREG/CR-6174. There are two principal changes in the revised scenarios. One is the delay of major decommissioning actions for at least 5 to 7 years following reactor shutdown because of a Department of Energy (DOE) requirement to cool the spent fuel in the reactor pool to avoid cladding failures in dry storage. The other is the assumption that decommissioning will be complete within 60 years, as required by current regulations. This delay results in an increase in decommissioning costs during the short safe storage period while the spent fuel pool continues to operate. Changes in cumulative occupational radiation doses also result from the decommissioning scenario changes.

The basic concept of the three alternatives remains unchanged. However, because of the accumulated inventory of spent fuel in the reactor storage pool and the requirement for at least 5 years of storage for the spent fuel before transfer to DOE for disposal, the timing and steps in the process for each alternative have been adjusted to reflect present conditions and possibilities. For the DECON alternative, it is assumed that the owner has strong incentives to decontaminate and dismantle the retired reactor facility as promptly as possible [i.e., future availability and cost of low-level radioactive waste (LLW) disposal and the need to reuse or dispose of the site, necessitating transfer of the stored spent fuel from the pool to a dry storage facility on the reactor site]. Although continued storage of spent fuel in the pool would be acceptable, the modified Part 50 license could not be terminated until the pool was emptied. It is also assumed that an acceptable dry transfer system would be available to remove the spent fuel from the dry storage facility and place it into licensed transport casks when the time came for DOE to accept the spent fuel for disposal. Similar assumptions are made for the SAFSTOR and ENTOMB alternatives for convenience of analysis, even though extended use of the spent fuel pool might be more cost-effective for SAFSTOR.

7.2.2.1 DECON

DECON is the decommissioning method in which the equipment, structures, and portions of the facility and site containing radioactive contaminants are removed or decontaminated to a level that permits the property to be released for unrestricted use shortly after cessation of operations. It is the only decommissioning alternative that leads to termination of the facility license and release of the facility and site for unrestricted use shortly after cessation of facility operations. DECON activities are expected to require about 9 years for large light-water reactors; less time should be required for smaller facilities.

Because DECON operations are expected to be completed within a few years following shutdown, radiation exposures to workers generally are higher than for decommissioning methods that allow for radioactive decay by delaying or extending the work over a longer period. DECON also requires larger commitments of money and commercial waste disposal site space than do other decommissioning methods. The principal advantage of DECON is that the site is available for unrestricted use promptly.

Nonradioactive equipment and structures need not be dismantled or removed for termination of the NRC license and release for unrestricted use. Once the facility's radioactive structures are decontaminated to levels permitting unrestricted use of the facility, nonradioactive facilities may either be put to some other use or demolished at the owner's discretion. [NRC has issued proposed amendments to 10 CFR Part 20 containing radiological criteria for decommissioning of NRC-licensed nuclear facilities (FR 59, 43200, August 22, 1994). Currently, NRC uses, on a case-by-case basis, criteria and practices contained in Regulatory Guide 1.86 and in a letter to Stanford University from J. Miller, Office of Nuclear Reactor Regulation, NRC, dated April 21, 1982.]

DECON, as defined by NUREG/CR-5884 and NUREG/CR-6174, comprises four distinct periods of effort: (1) preshutdown planning/engineering and regulatory reviews, (2) plant deactivation and preparation for storage (no dismantling activities are conducted during this period that would affect the safe operation of the spent fuel pool), (3) plant safe storage with concurrent operations in the spent-fuel pool until the pool inventory is zero, and (4) decontamination and dismantlement of the radioactive portions of the plant, leading to license termination. Because of the delays in development of the federal waste management system, it may be necessary to continue operation of a dry fuel storage facility on the reactor site after the reactor systems have been dismantled and the reactor nuclear license terminated. However, these latter storage costs are considered operations costs under 10 CFR 50.54(b)(b) and are not considered part of decommissioning.

7.2.2.2 SAFSTOR

SAFSTOR is the decommissioning method in which the nuclear facility is placed and maintained in a condition that allows the safe storage of radioactive components of the nuclear plant and subsequent decontamination to levels that permit release for unrestricted use. SAFSTOR was initially conceived of as having three successive stages: (1) a short period of preparation for safe storage (expected to be up to 2 years after final reactor shutdown); (2) a variable safe storage period of continuing care consisting of security, surveillance, and maintenance during which much of the reactor's radioactivity decays; and finally, (3) a relatively short period of decontamination (NUREG-0586). In NUREG/CR-5884 and NUREG/CR-6174, SAFSTOR is described as five distinct periods of effort, with the initial three periods identical to those of DECON. The fourth period is extended safe storage (50 years) with no fuel in the reactor storage pool, and the fifth period is decontamination and dismantlement of the radioactive portions of the plant.

The radioactive or contaminated material must be decontaminated or removed, packaged, and disposed of at a regulated disposal facility. After it has been determined that residual radioactivity is at acceptable levels, the license will be terminated and the facility can be released for unrestricted use. After termination of the NRC license, disassembly or demolition of nonradioactive facilities would be performed at the owner's discretion.

SAFSTOR may be used as a means of satisfying requirements for protection of the public while minimizing the initial commitments of time, money, radiation exposure, and waste disposal capacity. SAFSTOR may also have some advantage where there are other operational nuclear facilities at the same site or where a shortage of radioactive waste disposal capacity occurs. The disadvantages of SAFSTOR are that the site is unavailable for other uses for an extended time; maintenance, security, and surveillance are required until the final decontamination is complete; and few, if any, personnel familiar with the facility are available at the time of decontamination (up to 60 years after plant shutdown).

7.2.2.3 ENTOMB

ENTOMB is the alternative in which radioactive contaminants are encased in a long-lasting material, such as concrete. The entombed structure is maintained and surveillance is performed until the radioactivity decays to a level permitting release of the property for unrestricted use. ENTOMB also comprises five distinct periods of effort, with the initial three periods identical to those of DECON (NUREG/CR-5884 and NUREG/CR-6174). The fourth period is preparation for entombment, when all of the radioactive materials are consolidated within the containment building and entombed. The fifth period is entombed storage for an extended time, between 60 and 300 years.

ENTOMB is intended for use where the residual radioactivity will decay to levels permitting unrestricted release of the facility within reasonable time periods (100 years). However, a few radioactive isotopes produced in nuclear reactors have long half-life periods (Section 7.3.1) that prevent the release of the facilities for unrestricted use within the foreseeable lifetime of any man-made structure. ENTOMB would be a viable alternative only for facilities where radioactive isotopes would be expected to decay to safe levels within the expected lifetime of the entombment structure. This condition likely would not pertain to nuclear power reactors. In addition, the use of the ENTOMB alternative contributes to problems associated with increased numbers of sites dedicated to "interim" storage of radioactive materials for long periods of time.

7.2.3 Decommissioning Experience

U.S. commercial nuclear power reactors that have been shut down through 1992 are listed in Table 7.1. An additional 24 reactors have been or are being decommissioned in France, West Germany, Canada, the United Kingdom, Sweden, and Japan (Gaunt et al. 1990).

7.2.4 Inventory and Disposition of Radioactive Materials

Radioactive materials can be classified as activated or radioactively contaminated materials. Materials become activated when they have been exposed to (irradiated by) high levels of neutron radiation (such as in a reactor). When normal (stable) atoms in

Table 7.1 U.S. commercial nuclear power reactors formerly licensed to operate

Unit/ location	Construction type[a]/ MW(t)	Operating license issued/ shut down	Decommissioning alternative selected/ current status
Bonus[b] Punta Higuera, PR	BWR/50	04/02/64 06/01/68	ENTOMB ENTOMB
Carolina Virginia Tube Reactor[c] Parr, SC	PTHW/65	11/27/62 01/01/67	SAFSTOR SAFSTOR
Dresden 1 Morris, IL	BWR/700	09/28/59 10/31/78	SAFSTOR SAFSTOR
Elk River[b] Elk River, MN	BWR/58	11/06/62 02/01/68	DECON DECON completed
Fermi 1 Lagoona Beach, MI	SCF/200	05/10/63 09/22/72	SAFSTOR SAFSTOR
Fort St. Vrain Platteville, CO	HTG/842	12/21/73 08/18/89	DECON DECON in progress
GE Vallecitos Boiling Water Reactor Pleasanton, CA	BWR/50	08/31/57 12/09/63	SAFSTOR SAFSTOR
Hallam[b] Hallam, NE	SCGM/256	01/02/62 09/01/64	ENTOMB ENTOMB
Humboldt Bay 3 Eureka, CA	BWR/200	08/28/62 07/02/76	SAFSTOR SAFSTOR
Indian Point 1 Buchanan, NY	PWR/615	03/26/62 10/31/74	SAFSTOR NRC review
La Crosse Genoa, WI	BWR/165	07/03/67 04/30/87	SAFSTOR SAFSTOR
Pathfinder Sioux Falls, SD	BWR/190	03/12/64 09/16/67	SAFSTOR DECON in progress
Peach Bottom 1 Peach Bottom, PA	HTG/115	01/24/66 10/31/74	SAFSTOR SAFSTOR
Piqua[b] Piqua, OH	OCM/46	08/23/62 01/01/66	ENTOMB ENTOMB
Rancho Seco Herald, CA	PWR/2772	08/16/74 06/07/89	SAFSTOR NRC review

See notes at end of table.

Table 7.1 (continued)

Unit/ location	Construction type[a]/ MW(t)	Operating license issued/ shut down	Decommissioning alternative selected/ current status
San Onofre 1 San Clemente, CA	PWR/1347	03/27/67 11/30/92	SAFSTOR[d]
Shippingport[b] Shippingport, PA	PWR/236	N/A 82	DECON DECON completed
Shoreham Wading River, NY	BWR/2436	04/21/89 06/28/89	DECON DECON in progress
Three Mile Island 2 Londonderry Township, PA	PWR/2770	02/08/78 03/28/79	*e*
Trojan Portland, OR	PWR/3411	11/21/75 11/09/92	*f*
Yankee-Rowe Franklin County, MA	PWR/600	12/24/63 10/01/91	*g*

[a]BWR = boiling-water reactor; HTG = high-temperature gas-cooled; OCM = organically cooled and moderated; PTHW = pressure tube, heavy water cooled and moderated; PWR = pressurized-water reactor; SCF = sodium cooled,
fast; SCGM = sodium cooled, graphite moderated.
[b]Atomic Energy Commission/Department of Energy owned; not regulated by the Nuclear Regulatory Commission.
[c]Holds by-product license from state of South Carolina.
[d]San Onofre 1 decommissioning plan was due to the Nuclear Regulatory Commission in November 1994.
[e]Three Mile Island 2 has been placed in a monitored storage mode. The licensee plans to maintain the facility in monitored storage until Three Mile Island 1 permanently ceases operation, at which time both units are to be decommissioned simultaneously.
[f]Trojan received a possession-only license on 05/05/93. The license is evaluating SAFSTOR and DECON decommissioning alternatives. A decommissioning plan was due to the Nuclear Regulatory Commission in January 1995.
[g]Yankee Rowe received a possession-only license on 08/05/92. The licensee submitted a decommissioning plan on 12/20/93. Decommissioning alternative depends on the availability of low-level waste disposal facilities.
Source: DOE/RW-0006, rev. 6.

a material absorb neutrons, they become unstable (radioactive) and subsequently emit energy in the form of radiation. Radioactive contamination is radioactive material in the form of fine particles, liquids, or gases that are deposited on the surface of, or mixed with, materials that otherwise are not radioactive. Contaminated materials can generally be decontaminated to various degrees by several techniques. These techniques range from simply washing with soap and water to sandblasting contaminated surfaces. Decontamination techniques for liquids and gases include filtration and chemical ion exchange. Activated materials cannot be decontaminated; they remain radioactive until the radioactive constituents decay to stable isotopes.

Reactor components are generally both activated and contaminated. The principal activated components of a power plant are the reactor internals and the biological shield. Other reactor system components, such as the primary and possibly the secondary coolant loops, the turbines in BWRs, and the radioactive waste handling systems, are not activated but are highly contaminated by the contaminated fluids they contain. The major source of contamination in reactor coolant is the plant corrosion and wear material suspended in the coolant that becomes activated as it passes through the reactor core. Surface contamination can also be found in areas of the plant where leaks from contaminated systems have occurred.

The inventory of radionuclides for PWRs and BWRs is slightly different. A typical large PWR would have a radioactivity level of about 4.8 million Ci (1Ci = 3.7×10^{10} Bq) in the major reactor components, 4800 Ci of radioactive corrosion products in the primary coolant system, and 1200 Ci of radioactivity in the concrete biological shield at the time of shutdown (NUREG/CR-0130). A typical large BWR would have a radioactivity level of about 6.3 million Ci in the major reactor components, 8600 Ci of radioactive corrosion products in the primary coolant system, and 1000 Ci of radioactivity in the concrete biological shield at the time of shutdown (NUREG/CR-0672).

The principal radioactive isotopes from irradiated steel and concrete, with their modes of decay and their half-lives, are listed in Table 7.2. By the end of 40 years of operation, the radionuclides with half-lives of less than about 5 years are at equilibrium, because their rates of decay equal their rates of generation. No matter how much longer a power plant is operated, the concentration of short-half-life radionuclides will not increase. The longer-lived radionuclides are generated much faster than they decay; thus their concentrations increase approximately in proportion to the reactor operating time. Figure 7.3 illustrates the buildup of some important radionuclides as a function of nuclear plant operating life.

Radioactive isotopes that are mainly beta emitters or that have very short half-lives do not contribute significantly to the personnel radiation dose associated with decommissioning. Because beta radiation is weakly penetrating, it can be shielded easily and presents a hazard mainly if ingested or inhaled by operations personnel. Isotopes with very short half-life periods can be allowed to decay to insignificant levels before decommissioning operations begin.

At the time of decommissioning, radioactive materials are found in the reactor building, the auxiliary building, and the fuel building (Section 7.2.1). Immediately after operations are terminated, these parts of the plant are highly radioactive because of short-lived activation products. The highest levels of radioactivity subside very quickly as short-lived radionuclides decay and progressively longer-lived radionuclides dominate the overall radioactivity. After about a year, ^{60}Co dominates the radiation dose to workers. After about 100 years, ^{94}Nb dominates the radiation dose to workers or persons in the vicinity (Figure 7.4). For all practical purposes, the radiation dose to workers will not decrease further because ^{94}Nb has a 20,000-year half-life. Because ^{60}Co and ^{94}Nb dominate the radiation dose during the time of decommissioning, their characteristics affect the decommissioning process.

Both ^{60}Co and ^{94}Nb are activation products—isotopes created when neutrons from nuclear fission convert nonradioactive elements (^{59}Co and ^{93}Nb) in the structural components of the plant into radioactive

Table 7.2 Principal activated radioactive isotopes found in operating nuclear power plants (excluding fuel)

Element	Isotope	Decay mode[a]	Half-life (years)
Hydrogen	^{3}H	β	1.23×10^{1}
Carbon	^{14}C	β	5.73×10^{3}
Phosphorus	^{33}P	β	6.9×10^{-2}
Silicon	^{35}S	β	2.4×10^{-1}
Chlorine	^{36}Cl	β, γ	3.01×10^{5}
Argon	^{37}Ar	γ	9.5×10^{-2}
Argon	^{39}Ar	β	2.99×10^{2}
Potassium	^{40}K	β, γ	1.28×10^{9}
Calcium	^{41}Ca	γ	8.0×10^{4}
Calcium	^{45}Ca	β	4.5×10^{-1}
Scandium	^{46}Sc	β	2.3×10^{-1}
Chromium	^{46}Cr	γ	7.6×10^{-2}
Manganese	^{54}Mn	γ	$8. \times 10^{-1}$
Iron	^{55}Fe	γ	2.7×10^{0}
Iron	^{59}Fe	β, γ	1.2×10^{-1}
Cobalt	^{58}Co	γ	2.1×10^{-1}
Cobalt	^{60}Co	β, γ	5.27×10^{0}
Nickel	^{59}Ni	γ	8.0×10^{4}
Nickel	^{63}Ni	β	9.2×10^{1}
Zinc	^{65}Zn	γ	6.7×10^{-1}
Niobium	^{93m}Nb	γ	1.36×10^{1}
Niobium	^{94}Nb	β, γ	2.03×10^{4}
Niobium	^{95}Nb	β, γ	9.6×10^{-2}
Molybdenum	^{93}Mo	γ	3.5×10^{3}
Zirconium	^{95}Zr	β, γ	1.8×10^{-1}
Technetium	^{99}Tc	β	2.13×10^{5}
Silver	^{108m}Ag	β, γ	1.27×10^{2}
Silver	^{110m}Ag	β, γ	6.8×10^{-1}
Cadmium	^{109}Cd	γ	1.3×10^{0}
Samarium	^{151}Sm	β, γ	9.0×10^{1}
Europium	^{152}Eu	β, γ	1.33×10^{1}
Europium	^{154}Eu	β, γ	8.8×10^{0}
Holmium	^{166m}Ho	γ	1.2×10^{3}

[a]β = beta, γ = gamma (including x-rays).
Source: R. C. Weast, ed. *Handbook of Chemistry and Physics*, 53rd ed. 1972–73, Chemical Rubber Company, Cleveland, 1972.

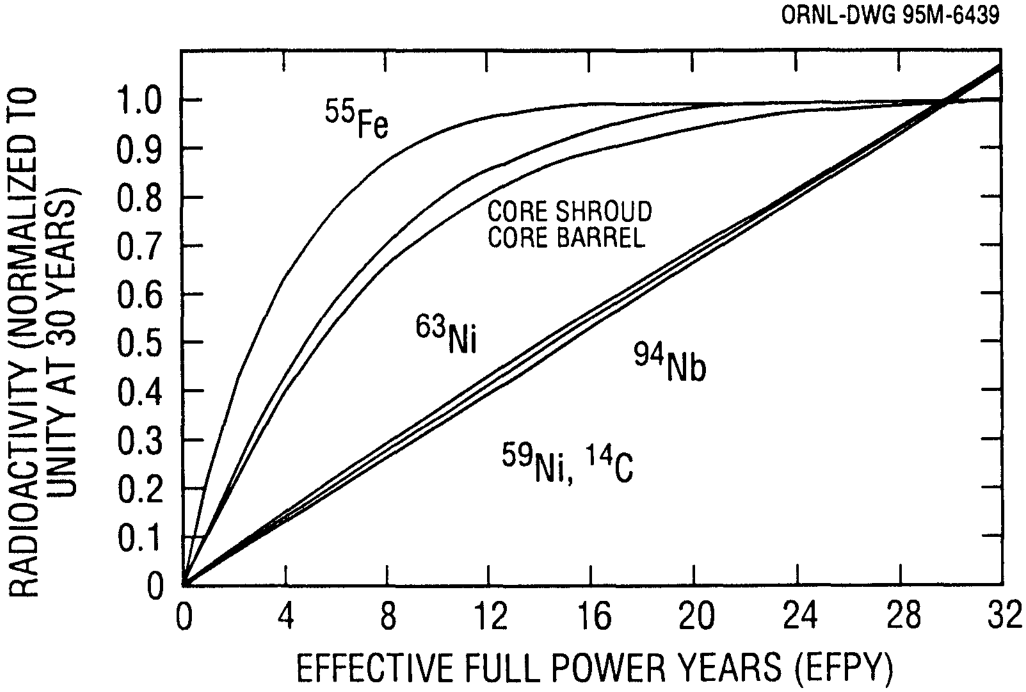

Figure 7.3 **Buildup of activation products in pressurized-water reactor internal components as a function of effective full-power years.** *Source:* NUREG/CR-0130.

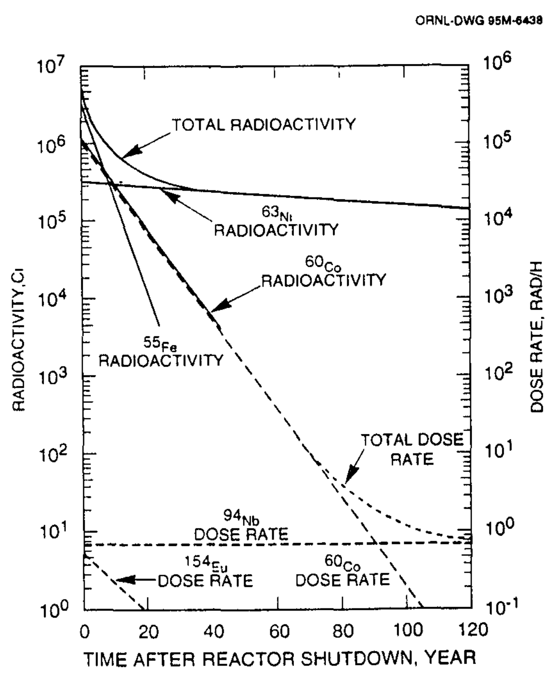

Figure 7.4 **Time dependence of radioactivity and dose rate in a boiling-water reactor core shroud after 40 years of operation.** *Source:* NUREG/CR-0672.

isotopes. An important difference is that ^{94}Nb in the steel reactor vessel and components, formed by activation of ^{93}Nb, is not subject to corrosion and movement throughout the primary system to the extent that ^{60}Co is. Consequently, equipment in the reactor containment building that is not exposed to high neutron fluxes and parts of the fuel and auxiliary buildings may be highly contaminated with ^{60}Co but only slightly so with ^{94}Nb.

Extending operations to 60 years would not increase the shutdown radioactivity level of either a PWR or BWR to any appreciable extent. This is because most of the radioactivity at shutdown results from short-half-life radionuclides, such as ^{60}Co, that are already in equilibrium by the time 40 years of operations have transpired. The only change in radioactive inventory resulting from the additional 20 years of operations is the further accumulation of long-half-life radionuclides such as ^{63}Ni and ^{94}Nb, but these long-half-life radionuclides produce only a small fraction of the total radioactivity at shutdown. Of the long-half-life radionuclides, ^{63}Ni contributes most at shutdown but composes less than 3 percent of the total radioactivity. Twenty additional years of operation would increase its contribution to about 4 percent of total shutdown radioactivity. Because ^{63}Ni is a beta emitter, it contributes only a very small part of the dose to workers or the public. Gamma-emitting ^{94}Nb is the most important long-half-life radionuclide with regard to producing external radiation exposure. Based on Figure 7.4, it can be determined that at shutdown ^{94}Nb contributes less than 0.001 percent of the total potential dose. Even though 20 additional years of operation would increase the amount of ^{94}Nb by 50 percent, it would not increase its contribution to the dose much above 0.001 percent.

7.2.5 Waste Generated During Decommissioning

This section summarizes the quantities and types of radioactive waste and emissions generated in decommissioning after 40 and 60 years of operation, respectively. Because the demolition and disposal of nonradioactive parts of nuclear facilities are not considered part of decommissioning, almost all waste generated during decommissioning is radioactive. Although the demolition and disposal of the nonradioactive parts may continue during and after decommissioning, these activities are not regulated by NRC. The impacts of radioactive wastes and emissions are described in Section 7.3. This section does not take into account volume reduction or aggressive processing that could allow release for unrestricted use.

7.2.5.1 Atmospheric Emissions

As shown in Table 7.3, the total atmospheric releases for decommissioning are less than 100 mCi, whereas normal operations average about 3000 Ci/year. Atmospheric releases are expected to consist largely of dust, aerosols, and smokelike particulates produced during the dismantling and handling of reactor components. These releases were estimated by assuming that the airborne concentrations of radionuclides will be a fraction of the contamination level on and in the radioactive components (NUREG/CR-0130 and NUREG/CR-0672). Because the radioactive inventory would be nearly unchanged by operations during a 20-year license renewal term, no difference exists between the base case and 20 years of additional operation.

Table 7.3 Airborne radioactive releases resulting from decommissioning typical pressurized-water reactors (PWRs) and boiling-water reactors (BWRs) with normal operating releases, base case (40 years of operation)[a]

	DECON (mCi)	SAFSTOR (mCi)	ENTOMB (mCi)	Normal operations (Ci/year)
PWR	0.86[b]	0.003[b]	NA[c]	2,600[d]
BWR	87[e]	0.21d[d]	2.25[d]	3,400[d]

[a]Decommissioning releases are for 40 years of operation. Releases for 60 years of operation would be essentially the same.
[b]*Source:* NUREG/CR-0130, Table 11.2-2.
[c]Not available.
[d]*Source:* DOE/EP-0093.
[e]*Source:* NUREG/CR-0672, Tables N.2-12, N.3-4, N.4-4, E.2-11. Decommissioning is assumed to last 5 years.

7.2.5.2 Liquid Effluents

No estimates of liquid waste releases are available for decommissioning nuclear power plants. However, liquids will be produced by decontamination procedures (e.g., some cutting operations and possibly some chemical decontamination procedures) and by disposal of plant fluids (e.g., cooling water and water from fuel storage pools). Filtration and ion exchange methods will be used to decontaminate liquids, as would be done during normal operations. Some liquid effluents may be contaminated with chelating agents and may require further processing. These methods are expected to keep waterborne effluents of most radionuclides within the values of normal operations. Tritium (^3H) is the only radioactive isotope that cannot be removed from waste water by these means.

Tritium is found principally in the primary coolant-loop water. Tritium cannot be removed from water except by extraordinary means and is normally discharged to a surface water body. Normal ^3H discharges from PWRs range from a few hundred to a few thousand curies per year. BWR ^3H discharges are generally only about 10 percent as high as ^3H discharges from PWRs. About 500 Ci of ^3H can be found in PWR primary coolant-loop water. Discharge of the entire volume of primary coolant-loop water over a period of 1 to 5 years after shutdown would be feasible without exceeding normal operating period discharge rates. The amounts or characteristics of liquid effluents discharged during decommissioning would not be changed by operation during a 20-year license renewal term. Discharge of primary coolant water during normal operations limits the accumulation of ^3H in the primary coolant loop; thus ^3H is in equilibrium in the primary coolant water well before 40 years of operation.

7.2.5.3 Solid Waste

Table 7.4 summarizes the quantities of LLW generated by decommissioning of large PWRs and BWRs. The table shows that the largest amount of LLW is

Table 7.4 Estimated burial volume of low-level waste and rubble for large pressurized-water reactor (PWR) and boiling-water reactor (BWR) decommissioning, base case (40 years of operation)

Decommissioning alternative	PWR (m^3)[a]	BWR (m^3)
DECON	6,992	14,282
SAFSTOR 1	763	1,117
SAFSTOR 2	6,992	14,282
ENTOMB 1	305	490
ENTOMB 2	754	1,139
ENTOMB 3	305	490

[a] 1 m^3 = 35.3 ft^3

Source: NUREG/CR-5884, Table ES.1 and NUREG/CR-6174, Table ES.1.

generated by the DECON method and the least is generated by the SAFSTOR method. The quantities listed for the ENTOMB method do not include the volume of the entombing structure or the wastes within.

The decommissioning waste volumes for all three methods of decommissioning also would not be affected by extending the volume of radioactive materials would not increase. (Operational waste quantities would continue, but they do not affect the amount of decommissioning waste.) An additional 20 years of operation would slightly affect the waste characteristics. As discussed in Section 7.2.4, the quantity of long-lived activation products such as ^{94}Nb would continue to increase, essentially in proportion to the additional operational time. As a result, the long-half-life radionuclides in the waste would increase by 50 percent if the plants were operated an additional 20 years. However, as explained earlier, these long-lived radionuclides contribute only a small fraction of the shutdown radioactivity level.

7.3 DECOMMISSIONING IMPACTS AND CHANGES RESULTING FROM LIFE EXTENSION

Estimated decommissioning impacts for 40 years of operation—the base case (taken primarily from NUREG-0586, NUREG/CR-0130, and NUREG/CR-0672)—and the change in impacts caused by continued operations for an additional 20 years under license renewal are reported for each impact area in the following sections. These impacts are estimated for PWRs and BWRs. The per-reactor impacts of decommissioning at multiple-reactor sites are not expected to be significantly different from those at single-reactor sites. [The impacts would be smaller at multiple reactor sites if the reactor decommissionings were staggered and if LLW were stored on the site (NUREG-0586)].

7.3.1 Radiation Dose

The estimated occupational and public radiation doses resulting from the three decommissioning methods after 40 years of operation (base case) are summarized in this section. Occupational dose estimates were presented in draft reports NUREG/CR-5884 and NUREG/CR-6174. These reports do not provide estimates of doses to the public. The Atomic Energy Act requires the Nuclear Regulatory Commission to promulgate, inspect, and enforce standards that provide an adequate level of protection of the public health and safety and the environment. These responsibilities, singly and in the aggregate, provide a margin of safety. For the purposes of assessing radiological impacts, the Commission has concluded that impacts are of small significance if doses and releases do not exceed permissible levels in the Commission's regulations.

7.3.1.1 Occupational Dose

For both PWRs and BWRs, there are substantial differences among the occupational radiation doses for the decommissioning methods (Table 7.5). The DECON method has the highest doses, followed by ENTOMB and then SAFSTOR. Although extending operations 20 years would increase the doses from ^{94}Nb and other less-important long-half-life radionuclides, these doses would not have any appreciable effect on the occupational dose because short-lived radionuclides (primarily ^{60}Co) are the principal sources of worker exposure. For each decommissioning method, the bulk of the dose comes during activities in the first few years after termination of plant operations (period four begins less than 5 years after terminating operations for DECON), when the radioactivity level of ^{60}Co is still significant. At the end of 60 years of SAFSTOR, the dose rate would have decayed to about 0.01 percent of the dose rate at the end of operations, at which time ^{94}Nb would contribute only about 2 percent of the total (Figure 7.4).

An additional 20 years of operation before 60 years of SAFSTOR would increase the amount of ^{94}Nb by approximately 50 percent. During period 5, occupational exposures from SAFSTOR activities would be no more than 10 person-rem. (Section E.A.3 of Appendix E discusses the International System units used in measuring radioactivity and radiation dose. The contribution from ^{94}Nb would be less than 0.2 person-rem. The increase in dose during decommissioning after 20 additional years of operation would be no more than about 0.1 person-rem.

Although total doses to the decommissioning workforce may increase slightly as a result of an additional 20 years of plant operation, the exposure of individual workers will be maintained well below the existing regulatory limits of 10 CRF Part 20. Accordingly, the Commission concludes that radiological impacts to the decontamination workforce as a result of license renewal is of small significance.

The potential increase in total dose to the decommissioning work force may be mitigated by programs that are responsive to 10 CFR 20.1101(b), which requires that "The licensee shall use, to the extent practicable, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA)." The ongoing ALARA programs within the industry already employ measures that would be considered for mitigating the generation or the accumulation of long-lived activation products during 20 additional years of operation. Two examples of mitigation measures that are already in use are (1) replacing components using cobalt alloys with those using low-cobalt or cobalt-free alloys and (2) full system decontamination (e.g., see

Table 7.5 Estimated occupational radiation doses for decommissioning a large reactor (person-rem), base case (40 years of operation)[a]

Decommissioning period[b]	DECON[c,d]	SAFSTOR[c,e]	ENTOMB[c,f]
	Pressurized-water reactor[g]		
1	—	—	—
2	207	207	207
3	21	21	21
4	704	88	562–589
5	NA	0-6	0
Totals[h]	931	315–322	790–816
	Boiling-water reactor[i]		
1	—	—	—
2	425	425	425
3	10	10	10
4	528	123	166–230
5	NA	0–10	0
Totals[h]	962	558–568	601–665

[a]Occupational radiation exposures are for decommissioning after 40 years of operations.
[b]Decommissioning periods are defined in NUREG/CR-6174 and NUREG/CR-5884.
[c]DECON, SAFSTOR, and ENTOMB are defined differently by NUREG/CR-5884 and NUREG/CR-6174 than by previous analyses.
[d]Table 3.1.
[e]Table 4.1.
[f]Table 5.2.
[g]*Source:* NUREG/CR-5884.
[h]Totals may not equal sum of entries because of rounding.
[i]*Source:* NUREG/CR-6174.

Moore 1995). No additional mitigation measures warranted. This is a Category 1 issue.

7.3.1.2 Dose to the Public

For both PWRs and BWRs, the radiation dose to the public results primarily from waste shipment (Table 7.6). Furthermore, the dose is almost exclusively caused by shipment of ^{60}Co and shorter-lived radionuclides; for truck shipments, the SAFSTOR 100-years alternative shows negligible dose to the public. Because only the quantities of long-lived radionuclides would increase if plants were operated an additional 20 years, only the dose caused by the long-lived radionuclides would increase. Because the dose to the public from long-lived radionuclides after 40 years

Table 7.6 Estimated radiation dose to the public for decommissioning a large reactor (person-rem), base case (40 years of operation)[a,b]

	DECON	SAFSTOR 30 years	SAFSTOR 100 years	ENTOMB
Pressurized-water reactor				
SAFSTOR preparation	NA	neg	neg	NA
Continuing care	NA	neg	neg	neg
Decontamination	neg[c]	neg[c]	neg[c]	NA
Entombment	NA	NA	NA	neg
SAFSTOR preparation truck shipments	NA	2	2	NA
Decontamination truck shipments	21[c]	0.4[c]	neg[c]	NA
Entombment truck shipments	NA	NA	NA	4
Totals	21	3	2	4
Boiling-water reactor				
SAFSTOR preparation	NA	neg	neg	NA
Continuing care	NA	neg	neg	neg
Decontamination	neg[c]	neg[c]	neg[c]	NA
Entombment	NA	NA	NA	neg
SAFSTOR preparation truck shipments	NA	2	2	NA
Decontamination truck shipments	10[c]	neg[c]	neg[c]	NA
Entombment truck shipments	NA	NA	NA	5–7[d]
Totals	10	2	2	5–7[d]

[a]Public radiation exposures are for decommissioning after 40 years of operation (NUREG-0586). Decommissioning exposures after 60 years would be identical, except as noted. Draft reports NUREG/CR-5884 and NUREG/CR-6174 do not provide updates for this information.
[b]NA means not applicable and neg means negligible.
[c]Decommissioning after 60 years of operation would increase occupational and public exposure during (1) decontamination and (2) decontamination truck shipments by only negligible amounts.
[d]Ranges are for removing or leaving internal components or leaving them in place. The higher exposures are associated with removing the internals.
Note: To convert person-rem to person-sievert, multiply by 0.01.

of operation is negligible (see the SAFSTOR 100-years alternative in Table 7.6), an increase of 50 percent of this negligible amount would still remain a negligible dose (less than 0.1 person-rem).

The negligible public radiation exposures for SAFSTOR preparation, continuing care, and decontamination (Table 7.6) include exposures from atmospheric and liquid releases during routine decommissioning operations. There are no historical records of significant releases during decommissioning, and no reliable estimates can be made of the probability and consequences of such events.

However, the probability and consequences of such releases are not expected to be different for decommissioning a base case facility versus decommissioning a facility that has had 20 years of additional operation.

Extending reactor operating life from 40 to 60 years is expected to increase the concentration of long-half-life radionuclides in the facility by up to 50 percent. By the end of the initial 40 years of operation, the radionuclides with half-lives of less than about 5 years are at equilibrium because their rates of decay equal their rates of generation. The release of radioactivity to the atmosphere during decontamination is negligibly small and primarily involves short-lived nuclides. Public exposure even with the increased concentration of long-lived nuclides would remain negligible. The exposure of individual members of the public will be maintained well below existing regulatory limits. Accordingly, the staff concludes that the contribution of license renewal to radiological impacts from decontamination is of small significance. As discussed in Section 7.3.1.1, measures that can reduce possible dose levels to the public are available and are being employed in pursuit of ALARA.

Radiation doses (public and occupational) from decommissioning that are attributable to license renewal are a Category 1 issue.

7.3.2 Waste Management Impacts

An operating 1000-MW(e) reactor generates about 38 m^3 (1300 ft^3) of spent fuel and about 52,000 m^3 (1,800,000 ft^3) of LLW over its 40-year life (NUREG-0586, pp. 2–21). (LLW is defined in Chapter 6.) The reference PWR and BWR are about 15 percent larger, so they would be expected to generate about 15 percent more waste than a 1000-MW(e) plant. As shown by Table 7.4, decommissioning either type of plant after 40 years of operation (base case) would generate less than 15,000 m^3 (530,000 ft^3) of LLW for DECON or short-term SAFSTOR and less than 1,200 m^3 (42,000 ft^3) of LLW for SAFSTOR of 50 years or longer. These waste volumes include spent chelating agent used to decontaminate liquids. The 15,000 m^3 (530,000 ft^3) of decommissioning LLW is about 25 percent, and 1,200 m^3 (42,000 ft^3) is only about 2 percent, of the LLW generated by 40 years of operations. None of these estimates of waste volume includes waste generation during refurbishment.

Extending operations by 20 years would not increase decommissioning waste volumes, so the ratio of decommissioning waste volume to operating waste volume would be even lower. After 60 years of operation, decommissioning LLW would be less than about 20 percent of the operational LLW. If SAFSTOR were used, the decommissioning LLW would be only about 1 percent of the LLW generated by operations.

While the volume of decommissioning waste will not increase with 20 years of additional operating time, the concentration of long-half-life radionuclides will increase. LLW is classified by 10 CFR Part 61 into three waste classes denoted A, B, and C and a category of LLW designated "greater than Class C" (GTCC). Classes A and B are wastes that are contaminated with relatively short-half-life radionuclides and may be safely disposed of near the earth's surface because they will decay to a nonhazardous condition within about 100 years. Class C waste can be disposed of at a moderate depth or near the earth's surface with engineered barriers to prevent inadvertent intrusion into the wastes. GTCC waste cannot safely be disposed of near the earth's surface (Section 6.2.2.2; 10 CFR Part 61.7).

Table 7.7 gives the estimated decommissioning LLW breakdown (DECON scenario) for the base case by waste class per 10 CFR Part 61. Items classified as C and GTCC consist of highly activated metal located in the high-flux neutron field. For the PWR, the GTCC items include the lower core barrel, the thermal shields, the core shroud, and the lower grid plate. The class C items are the upper grid plate and the lower support column. The class B wastes consist of spent resins used during decommissioning, part of the combustible contaminated wastes, and part of the cylindrical pressure vessel wall. The only GTCC wastes from a BWR are the core shroud and top fuel guide. BWR class C wastes are from the control rods and in-core instrumentation, jet pump assemblies, and the top fuel guide. The class B wastes are from the steam separator assembly, the reactor vessel wall, and portions of the clean-up wastes.

Table 7.7 Decommissioning waste volumes for reference pressurized-water reactor (PWR) and boiling-water reactor (BWR) after 40 years of operation[a]

	Class A	Class B/C	GTCC[b]
PWR	6,797 m^3	184 m^3	11 m^3
BWR	13,903 m^3	372 m^3	6.9 m^3

[a]DECON decommissioning method. Other methods would have smaller volumes of Class A and B wastes; Class C and GTCC wastes volumes would not change for other methods. A plant that has operated 60 years would have essentially the same waste volumes and classifications.
[b]GTCC = greater than Class C.
Source: NUREG/CR-5884 and NUREG/CR-6174.
Note: 1 m^3 = 35.3 ft^3.

The radionuclides of most importance for determining the classification of these LLWs are those that have relatively long half-life periods, such as ^{59}Ni and ^{94}Nb. These are also the radionuclides that accumulate in proportion with the length of reactor operation. The estimates in Table 7.7 are made for a plant that has operated 40 years. A plant that has operated 60 years would have essentially the same decommissioning waste volumes and classifications. Because the radionuclide concentration differences among waste classes are large (factors of 10 or more) and because the concentrations of radionuclides increase by no more than 50 percent, few components would be advanced to a higher classification by an additional 20 years of operations. Because the decommissioning waste volumes and classifications are essentially unchanged by an additional 20 years of plant operation, the Commission finds that the environmental impacts of decommissioning waste due to license renewal are of small significance. Measures employed within the context of ALARA, as discussed in Section 7.3.1.1, have the potential to reduce slightly the volume of LLW generated by decommissioning. The impact on decommissioning waste management attributable to license renewal is a Category 1 issue.

7.3.3 Air Quality Impacts

Air quality impacts of decommissioning are expected to be negligible. No major land disturbance for construction laydown or temporary waste storage areas is anticipated. The principal air quality impacts would result from motor vehicles operated by workers for transportation on-site and for movement of people and materials to and from the site. Most decommissioning activities would be conducted inside the containment, the auxiliary building, and the fuel-handling buildings. Because there would be a possibility of airborne releases of radioactivity within these buildings during decommissioning, releases to the ambient environment would be controlled. These impacts would be much smaller than those associated with construction or demolition of the facilities on-site and would not change with 20 additional years of operation. License renewal and an additional 20 years of reactor operation will have no impact on air quality during decommissioning; thus the impact of license renewal on decommissioning air quality impacts is of small significance for all plants. Because license renewal does not affect the level of air pollution during decommissioning, there is no need for the consideration of mitigation as part of the license renewal environmental review. The impact of decommissioning on air quality attributable to license renewal is a Category 1 issue.

7.3.4 Water Quality Impacts

The principal water quality impacts expected from decommissioning are those associated with sanitary sewer operations. Because the decommissioning work force is likely to be smaller than those of construction and certain operational activities (see Section 7.3.7), no increase in water quality impacts is expected. Soil erosion and chemical spills associated with increased site activities during decommissioning have the potential to degrade water quality, but such effects are readily controllable. The potential for significant water quality impacts from erosion or spills is no greater if decommissioning occurs after a 20-year license renewal instead of after the original 40 years of operation. Measures to minimize occupational and public radiation exposure will also protect water quality. License renewal and an additional 20 years of reactor operation will have no impact on water quality during decommissioning; thus the impact is of small significance. Because license renewal does not affect water quality impacts during decommissioning, there is no need for the consideration of mitigation as part of the license renewal environmental review. The impact of decommissioning on water quality impacts attributable to license renewal is a Category 1 issue.

7.3.5 Ecological Impacts

Terrestrial biota impacts, if any, would be associated with land disturbance for laydown or temporary waste storage areas, and no such land disturbance is anticipated. No direct impacts to aquatic biota are expected from routine decommissioning activities. Measures employed to protect water quality will also prevent toxic effects to aquatic organisms from liquid effluents. Therefore, the ecological impacts associated with decommissioning are not expected to vary with the length of time the plant is operated. Decommissioning after a 20-year license renewal would have the same ecological impacts, if any, as decommissioning after 40 years of operation; thus the impact is of small significance. Because license renewal does not affect ecological impacts during decommissioning, there is no need for the consideration of mitigation as part of the license renewal environmental review. The impact of decommissioning on ecological resources attributable to license renewal is a Category 1 issue.

7.3.6 Economic Impacts

In general, the nature of the activities and the elements of the costs associated with decommissioning are well understood, and the necessary skills and equipment should be readily available when needed. Table 7.8 lists percentage estimates of total costs for decommissioning large PWR and BWR reactors by the DECON method.

A 1991 national survey had estimates that averaged $218 million per 1000 MW for a PWR reactor and $283 million per 1000 MW for a BWR. The standard deviation was $74 million for PWRs and $144 million for BWRs. For both types of reactors, the range for plus and minus one standard deviation was $131 million to $350 million (OTA-E-575). These varying estimates reflect the uncertainty of projecting costs well into the future. Additionally, the unique aspects of a plant's design and operating history can affect decommissioning costs (e.g., Three Mile Island Unit 2 and Fort St. Vrain).

The largest cost category is "undistributed"; the largest component of this cost is utility support staff. The timing of decommissioning could influence disposal costs depending on the price of disposal services. The current trend is steeply increasing cost per units of radioactive waste disposal. If this trend continues over the long run, then one effect of license renewal could be to increase decommissioning costs. However, disposal costs should stabilize by the time that most existing plants would be eligible for license renewal. If this is the case, license renewal would have a minimal effect on the undiscounted costs of decommissioning after a 20-year extended operation period, compared with after 40 years of operation.

For the cost estimates included in Table 7.8, doubling the cost per cubic foot of waste disposal would increase total decommissioning costs by about 13 percent for PWRs and 20 percent for BWRs. The assumed rate charged for disposal would have to increase by a factor of about 6 to double the total cost of decommissioning. If the rate of disposal costs turns out to be significantly more than has been assumed in decommissioning cost estimates, there would tend to be significantly more attention devoted to volume reduction; thus, total cost of disposal would tend to increase less than the proportional increase in the rate charged per cubic foot (NUREG/CR-5884, vol. 1, pp. 3.56, 3.57, and NUREG/CR-6174, vol. 1, p. 3.55).

The timing of decommissioning could also affect costs if progress in robotics technology reduces costs and worker radiation exposure. This progress would affect a relatively small part of the decommissioning process and thus is unlikely to reduce the total cost of decommissioning significantly; however, it could result in substantial dose reductions.

The preceding sections show that there is no reason to expect the physical requirements of decommissioning to be materially different when comparing the base case to a 20-year extended operation period. The undiscounted economic costs, although uncertain, should also be relatively stable and thus unaffected by license renewal. However, because of financial considerations, the timing of

Table 7.8 Summary and distribution of decommissioning costs for large pressurized-water reactors (PWRs) and boiling-water reactors (BWRs) (thousands of 1993 dollars)

Decommissioning alternative	Duration[a] (years)	Decon[b] (%)	Removal[c] (%)	Packaging[d] (%)	Transport[e] (%)	Disposal[f] (%)	Undistributed[g] (%)	Present value[h] of total cost ($ × 10^3)	Present value[h] of savings[i] for license renewal ($ × 10^3)
Pressurized-water reactor									
DECON	11	16.7	9.5	1.6	3.3	17.0	51.9	101,600	41,032
SAFESTOR1	59	11.0	0.5	0.3	1.0	3.4	83.8	93,000	37,559
SAFESTOR2	60	9.1	5.2	0.9	1.8	9.1	74.0	101,900	41,153
ENTOMB1	60	NA	NA	NA	NA	NA	NA	104,300	42,123
ENTOMB2	60	NA	NA	NA	NA	NA	NA	106,100	42,850
ENTOMB3	300	NA	NA	NA	NA	NA	NA	109,500	44,223
Boiling-water reactor									
DECON	9	11.1	9.2	2.6	0.9	27.3	48.9	133,250	53,814
SAFESTOR1	59	7.6	1.0	0.2	0.5	3.1	87.5	121,600	49,109
SAFESTOR2	60	5.8	4.8	1.4	0.5	14.1	73.5	134,200	54,198
ENTOMB1	60	NA	NA	NA	NA	NA	NA	151,900	61,346
ENTOMB2	60	NA	NA	NA	NA	NA	NA	155,200	62,679
ENTOMB3	300	NA	NA	NA	NA	NA	NA	164,500	66,435

[a]Preshutdown period not included in duration total.
[b]Includes direct decommissioning labor and materials for chemical decontamination of systems, cleaning of surfaces, and waste water treatment.
[c]Includes direct labor and materials costs of removal.
[d]Includes direct costs of waste disposal packages.
[e]Includes cask rental costs and transportation costs.
[f]Includes all costs of disposal at the LLW disposal facility.
[g]Includes all costs that are period-dependent—e.g., decommissioning operations contractor (DOC) mobilization/demobilization, utility and DOC overhead staff, nuclear insurance, regulatory costs, plant power usage, taxes, laundry services, environmental monitoring. Most of the undistributed costs are for staffing.
[h]At 3 percent discount rate.
[i]The decommissioning costs have been discounted at a rate of 3 percent real (assumes no inflation). At this rate, delaying decommissioning by the 20-year period of license renewal saves about 45 percent of the decommissioning cost; however, present value total costs have been figured at 2.5 years from final plant shutdown, resulting in savings from license renewal of about 40 percent.
Source: Tables 3.1 and 4.1 and pp. 3.59, 4.13, and 5.13 of NUREG/CR-5884, Vol. 1; Tables 3.1 and 4.1 and pp. 3.58, 4.12, and 5.11 of NUREG/CR-6174, Vol. 1.

decommissioning costs is important. To compare costs of activities that occur at different times, it is necessary to discount these costs to a common point in time. This is accomplished through present worth calculations, which account for the real opportunity cost or time value of money. Delaying decommissioning will allow any funds accumulated for this purpose to earn a return over the additional 20 years of license renewal and thus to reduce the present value of the decommissioning costs. The reduction in the present value is a function of the delay (license renewal period) and the time value of money, so the present value would be reduced by the same amount even if no fund were established and decommissioning were financed with borrowed money at the end of the plant operations. Regardless of how it is financed, the present value of delaying decommissioning costs will result in significant financial cost savings if a positive real discount rate is assumed.

Because total decommissioning costs are uncertain, the amount of financial savings that results from delaying decommissioning is also uncertain. Higher-than-expected decommissioning costs would result in higher cost savings resulting from delaying these costs, and vice versa. At a 3 percent real (i.e., above general inflation) discount rate, the present value savings associated with license renewal is about 40 percent of decommissioning costs (Table 7.8). Real cost increases, which might occur for waste disposal costs, could reduce the cost advantage of license renewal, but waste disposal costs are expected to stabilize before the current licenses of most plants expire. The impact of license renewal on decommissioning costs is not a consideration in the environmental review and decision whether to renew a license.

7.3.7 Socioeconomic Impacts

Socioeconomic impacts associated with decommissioning will be induced by the net change in the labor force as incoming decommissioning workers replace emigrating operations workers. The nature of these impacts will depend on the vitality of local economic activity at the time of decommissioning.

One of the difficulties of attempting to evaluate the socioeconomic impacts of decommissioning in year 40 of a plant's life compared with decommissioning in year 60 relates to the uncertainties about the size of the work force required. The largest nuclear power plant decommissioned to date has been the 150-MW(e) Shippingport Station (Section 7.2.3), which required an average work force during the peak year of approximately 230 workers (DOE/SSDP-0081); this work force was larger than the estimated work forces for very large power plants examined in studies prepared before the Shippingport experience (NUREG/CR-0130, Table 9.1-1; NUREG/CR-0672, Table 9.1-3). Because more-recent manpower estimates for large nuclear power plants are not available, the actual work force required in the future might be substantially larger than currently expected.

If the decommissioning process requires a smaller work force than the on-site operating staff and if the local economy is stable or declining, the result could be economic hardships, including declining property values and business activity, and problems for local government as it adjusts to lower levels of tax revenues. However, even this reduced work force will tend to mitigate temporarily the full adverse socioeconomic effects of terminating operations.

If there is a net reduction in the community work force but the economy is growing, the adverse impacts of this ongoing growth (e.g., housing shortages and school overcrowding) could be reduced.

If the decommissioning work force were substantially larger than the operational work force, the result could be increased demand for housing and public services but also increased tax revenues and higher real estate values. If the economy is characterized by decline, decommissioning could temporarily reverse the adverse economic effects.

In a stable economy, a net increase in the community work force could lead to some shortages in housing and public services, as well as to the higher tax revenues and real estate values mentioned previously. In a growing economy, decommissioning could act as an exacerbating factor to the ongoing shortages that already might exist.

Although the staff cannot project with certainty either the size of the required decommissioning work force or the state of the local economy at the time of decommissioning, the staff has assumed that the baseline conditions will be negligibly different in year 40, compared with year 60. Therefore, the staff expects that the socioeconomic impacts of decommissioning would be essentially similar whether that action were taken in year 60 or in year 40. The impact of license renewal on the socioeconomic impacts of decommissioning are of small significance. Because license renewal does not affect the socioeconomic impacts that will occur at the time of decommissioning, there is no need for the consideration of mitigation as part of the license renewal environmental review. The impact of decommissioning on socioeconomic resources attributable to license renewal is a Category 1 issue.

7.4 CONCLUSIONS

The physical requirements and attendant effects of decommissioning nuclear power plants after a 20-year license renewal are not expected to differ from those of decommissioning at the end of 40 years of operation. Decommissioning after a 20-year license renewal would increase the occupational dose no more than 0.1 person-rem (compared with 7,000 to 14,000 person-rem for DECON decommissioning at 40 years) and the public dose by a negligible amount (Section 7.3.1). License renewal would not increase to any appreciable extent the quantity or classification of LLW generated by decommissioning (Section 7.3.2). Air quality, water quality, and ecological impacts of decommissioning would not change as a result of license renewal (Sections 7.3.3, 7.3.4, and 7.3.5). There is considerable uncertainty about the cost of decommissioning; however, while license renewal would not be expected to change the ultimate cost of decommissioning, it would reduce the present value of the cost (Section 7.3.6). The socioeconomic effects of decommissioning will depend on the magnitude of the decommissioning effort, the size of the community, and the other economic activities at the time, but the impacts will not be increased by decommissioning at the end of a 20-year license renewal instead of at the end of 40 years of operation (Section 7.3.7). Incremental radiation doses, waste management, air quality, water quality, ecological, and socioeconomic impacts of decommissioning due to operations during a 20-year license renewal term would be of small significance. No mitigation measures beyond those provided by ALARA are warranted within the context of the license renewal process. The impacts of license renewal on radiation doses, waste management, air quality, water quality, ecological resources, and socioeconomics impacts from decommissioning are Category 1 issues.

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NUCLEAR REGULATORY COMMISSION

10 CFR Part 51

RIN 3150–AD63

Environmental Review for Renewal of Nuclear Power Plant Operating Licenses

AGENCY: Nuclear Regulatory Commission.

ACTION: Final rule.

SUMMARY: The Nuclear Regulatory Commission (NRC) is amending its regulations regarding environmental protection regulations for domestic licensing and related regulatory functions to establish new requirements for the environmental review of applications to renew the operating licenses of nuclear power plants. The amendment defines those environmental impacts for which a generic analysis has been performed that will be adopted in plant-specific reviews for license renewal and those environmental impacts for which plant-specific analyses are to be performed.

The amendment improves regulatory efficiency in environmental reviews for license renewal by drawing on the considerable experience of operating nuclear power reactors to generically assess many of the environmental impacts that are likely to be associated with license renewal. The amendment also eliminates consideration of the need for generating capacity and of utility economics from the environmental reviews because these matters are under the regulatory jurisdiction of the States and are not necessary for the NRC's understanding of the environmental consequences of a license renewal decision.

The increased regulatory efficiency will result in lower costs to both the applicant in preparing a renewal application and to the NRC for reviewing plant-specific applications and better focus of review resources on significant case specific concerns. The results should be a more focused and therefore a more effective NEPA review for each license renewal. The amendment will also provide the NRC with the flexibility to address unreviewed impacts at the site-specific stage of review and allow full consideration of the environmental impacts of license renewal.

The NRC is soliciting public comment on this rule for a period of 30 days. In developing any comment specific attention should be given to the treatment of low-level waste storage and disposal impacts, the cumulative radiological effects from the uranium fuel cycle, and the effects from the disposal of high-level waste and spent fuel.

DATES: Absent a determination by the NRC that the rule should be modified, based on comments received, the final rule shall be effective on August 5, 1996. The comment period expires on July 5, 1996.

ADDRESSES: Send comments to: The Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001, Attention: Docketing and Services Branch, or hand deliver comments to the Office of the Secretary, One White Flint North, 11555 Rockville Pike, Rockville, Maryland between 7:30 a.m. and 4:15 p.m. on Federal workdays. Copies of comments received and all documents cited in the supplementary information may be examined at the NRC Public Document Room, 2120 L Street NW. (Lower Level), Washington, DC between the hours of 7:45 a.m. and 4:15 p.m. on Federal workdays.

FOR FURTHER INFORMATION CONTACT: Donald P. Cleary, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001, telephone: (301) 415–6263; e-mail DPC@nrc.gov.

SUPPLEMENTARY INFORMATION:

I. Introduction

The Commission has amended its environmental protection regulations in 10 CFR part 51 to improve the efficiency of the process of environmental review for applicants seeking to renew an operating license for up to an additional 20 years. The amendments are based on the analyses conducted for and reported in NUREG–1437, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants'' (May 1996). The Commission's initial decision to undertake a generic assessment of the environmental impacts associated with the renewal of a nuclear power plant operating license was motivated by its beliefs that:

(1) License renewal will involve nuclear power plants for which the

environmental impacts of operation are well understood as a result of data evaluated from operating experience to date;

(2) Activities associated with license renewal are expected to be within this range of operating experience, thus environmental impacts can be reasonably predicted; and

(3) Changes in the environment around nuclear power plants are gradual and predictable with respect to characteristics important to environmental impact analyses.

Although this amendment is consistent with the generic approach and scope of the proposed amendment published on September 17, 1991 (56 FR 47016), several significant modifications have been made in response to the public comments received. The proposed amendment would have codified the findings reached in the draft generic environmental impact statement (GEIS) as well as certain procedural requirements. The draft GEIS established the bounds and significance of potential environmental impacts at 118 light-water nuclear power reactors that, as of 1991, were licensed to operate or were expected to be licensed in the future.

All potential environmental impacts and other matters treated by the NRC in an environmental review of nuclear power plants were identified and combined into 104 discrete issues. For each issue, the NRC staff established generic findings encompassing as many nuclear power plants as possible. These findings would have been codified by the proposed amendment. Of the 104 issues reviewed for the proposed rule, the staff determined that 80 issues could be adequately addressed generically and would not have been reviewed in plant-specific license renewal reviews. For 22 of the issues, it was found that the issue was adequately addressed for some but not all plants. Therefore, a plant-specific review would be required to determine whether the plant is covered by the generic review or whether the issue must be assessed for that plant. The proposed amendment provided guidance on the application of these findings at the site-specific license renewal stage. For the two remaining issues, it was found that the issue was not generically addressed for any plant, and thus a plant-specific review would have been required for all plants.

Other major features of the proposed amendment included a conditional finding of a favorable cost-benefit balance for license renewal and a provision for the use of an environmental assessment that would address only those issues requiring plant-specific review. A finding of no significant impact would have resulted in a favorable cost-benefit balance for that plant. If a finding of no significant impact could not be made for the plant, there would have to have been a determination as to whether the impacts found in the environmental assessment were sufficient to overturn the conditional cost-benefit balance found in the rule.

Although the final amendments to 10 CFR part 51 maintain the same generic approach used in the proposed rule, there are several modifications.The final amendments to 10 CFR part 51 now contain 92 issues. The reduction of the number of issues from 104 in the proposed rule to 92 in the final rule is due to (1) the elimination from the review of the consideration of the need for electric power and associated generating capacity and of the direct economic benefits and costs associated with electric power, (2) removing alternatives as an issue from Table B–1 and addressing review requirements only in the text of the rule, (3) combining the five severe accident issues used in the proposed rule into one issue, (4) eliminating several regional economic issues under socioeconomics that are not directly related to environmental impacts, (5) making minor changes to the grouping of issues under aquatic ecology and groundwater, (6) identifying collective offsite radiological impacts associated with the fuel cycle and all impacts of high level waste and spent fuel disposal as separate issues, and (7) adding environmental justice as an issue for consideration.

Of the 92 issues in the final rule, 68 issues were found to be adequately addressed in the GEIS, and therefore, additional assessment will not be required in a plant-specific review. Twenty-four issues were found to require additional assessment for at least some plants at the time of the license renewal review. In the final rule, the 2 issues in the proposed rule that would have required review for all plants are now included in the set of 24 issues of the final rule.

Public comments on the adequacy of the analysis for each issue were considered by the NRC staff. Any changes to the analyses and findings that were determined to be warranted were made in the final GEIS and incorporated in the rule. Several changes were made to the procedural features of the proposed rule in response to comments by the Council on Environmental Quality, the Environmental Protection Agency, and a number of State agencies. First, the NRC will prepare a supplemental site-specific environmental impact statement (SEIS), rather than an environmental assessment (as initially proposed), for each license renewal application. The SEIS will be issued for public comment as part of the individual plant review process. The NRC will delay any conclusions regarding the acceptability of the overall impacts of the license renewal until completion of the site-specific review. In addition, the SEIS will be prepared in accordance with existing public scoping requirements. The NRC will also review and consider any new and significant information presented during the review of individual license renewal applications. In addition, any person may challenge the validity of the conclusions codified in the rule by filing a petition for rulemaking pursuant to 10 CFR 2.802. Finally, the NRC will review the rule and the GEIS on a schedule that allows revisions, if required, every 10 years. This review will be initiated approximately 7 years after the completion of the previous revision cycle.

In addition to the changes involving public participation, this final rule also contains several changes regarding the scope of analysis and conclusions in the rule and GEIS. The conditional cost-benefit balance has been removed from the GEIS and the rule. In place of the cost-benefit balancing, the NRC will use a new standard that will require a determination of whether or not the adverse environmental impacts of license renewal are so great, compared with the set of alternatives, that preserving the option of license renewal for future decisionmakers would be unreasonable. The final amendment also eliminates NRC's consideration of the need for generating capacity and the preparation of power demand forecasts for license renewal applications. The NRC acknowledges the primacy of State regulators and utility officials in defining energy requirements and determining the energy mix within their jurisdictions. Therefore, the issue of need for power and generating capacity will no longer be considered in NRC's license renewal decisions. The final GEIS has been revised to include an explicit statement of purpose and need for license renewal consistent with this acknowledgment. Lastly, the final rule has eliminated the consideration of utility economics from license renewal reviews under the National Environmental Policy Act (NEPA) except when such benefits and costs are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation. These and other features of the final rule are explained in detail below.

The NRC is soliciting public comment on this rule for a period of 30 days. In developing any comment specific attention should be given to the treatment of low-level waste storage and disposal impacts, the cumulative radiological effects from the uranium fuel cycle, and the effects from the disposal of high-level waste and spent fuel. Absent a determination by the NRC that the rule should be modified, based on comments received, the final rule shall be effective on August 5, 1996.

II. Rulemaking History

In 1986, the NRC initiated a program to develop license renewal regulations and associated regulatory guidance in anticipation of applications for the renewal of nuclear power plant operating licenses. A solicitation for comments on the development of a policy statement was published in the Federal Register on November 6, 1986 (51 FR 40334). However, the Commission decided to forgo the development of a policy statement and to proceed directly to rulemaking. An advance notice of proposed rulemaking was published on August 29, 1988 (53 FR 32919). Subsequently, the NRC determined that, in addition to the development of license renewal regulations focused on the protection of health and safety, an amendment to its environmental protection regulations in 10 CFR part 51 was warranted.

On October 13, 1989 (54 FR 41980), the NRC published a notice of its intent to hold a public workshop on license renewal on November 13 and 14, 1989. One of the workshop sessions was devoted to the environmental issues associated with license renewal and the possible merit of amending 10 CFR part 51. The workshop is summarized in NUREG/CP–0108, ''Proceedings of the Public Workshop on Nuclear Power Plant License Renewal'' (April 1990). Responses to the public comments submitted after the workshop are summarized in NUREG–1411, ''Response to Public Comments Resulting from the Public Workshop on Nuclear Power Plant License Renewal'' (July 1990).

On July 23, 1990, the NRC published an advance notice of proposed rulemaking (55 FR 29964) and a notice of intent to prepare a generic environmental impact statement (55 FR 29967). The proposed rule was published on September 17, 1991 (56 FR 47016). The same Federal Register notice described the supporting documents that were available and announced a public workshop to be held on November 4–5, 1991. The supporting documents for the proposed rule included:

(1) NUREG–1437, ''Draft Generic Environmental Impact Statement for License Renewal of Nuclear Plants'' (August 1991);

(2) NUREG–1440, ''Regulatory Analysis of Proposed Amendments to Regulations Concerning the Environmental Review for Renewal of Nuclear Power Plant Operating Licenses: Draft Report for Comment'' (August 1991);

(3) Draft Regulatory Guide DG–4002, Proposed Supplement 1 to Regulatory Guide 4.2, ''Guidance for the Preparation of Supplemental Environmental Reports in Support of an Application To Renew a Nuclear Power Station Operating License'' (August 1991); and

(4) NUREG–1429, ''Environmental Standard Review Plan for the Review of License Renewal Applications for Nuclear Power Plants: Draft Report for Comment'' (August 1991).

After the comment period, the NRC exchanged letters with the Council on Environmental Quality (CEQ) and the Environmental Protection Agency (EPA) to address their concerns about procedural aspects of the proposed rule. The Commission also decided that the staff should discuss with the States the concerns raised in comments by a number of States that certain features of the proposed rule conflicted with State regulatory authority over the need for power and utility economics. To facilitate these discussions, the NRC staff developed an options paper entitled ''Addressing the Concerns of States and Others Regarding the Role of Need for Generating Capacity, Alternative Energy Sources, Utility Costs, and Cost-Benefit Analysis in NRC Environmental Reviews for Relicensing Nuclear Power Plants: An NRC Staff Discussion Paper.'' A Federal Register notice published on January 18, 1994 (59 FR 2542) announced the scheduling of three regional workshops during February 1994 and the availability of the options paper. A fourth public meeting on the State concerns was held in May 1994 in order for the NRC staff to better understand written proposals that had been submitted by two industry organizations after the regional workshops. After considering the comments from the workshops and the written comments, the NRC staff issued a proposed supplement to the proposed rule published on July 25, 1994 (59 FR 37724), that it believed would resolve the States' concerns regarding the Commission's consideration of need for power and utility economics. Comments were requested on this proposal. The discussion below contains an analysis of these comments and other comments submitted in response to the proposed rule.

III. Analysis of Public Comments

The analysis of public comments and the NRC's responses to these comments are documented in NUREG–1529, ''Public Comments on the Proposed 10 CFR part 51 Rule for Renewal of Nuclear Power Plant Operating Licenses and Supporting Documents: Review of Concerns and NRC Staff Response'' (May 1996). The extent of comments received during the various stages of the rulemaking process and the principal concerns raised by the commenters, along with the corresponding NRC responses to these concerns, are discussed below.

A. Commenters

In response to the Federal Register notice on the proposed rule published on September 17, 1991 (56 FR 47016), 68 organizations and 49 private citizens submitted written comments. The 68 organizations included 5 Federal agencies; 26 State, regional, and local agencies; 19 nuclear industry organizations and engineering firms; 3 law firms; and 15 public interest groups. Before the close of the initial comment period, the NRC conducted a 2-day workshop on November 4–5, 1991, in Arlington, Virginia, to discuss the proposed rule. Representatives from Federal agencies, State agencies, utilities, engineering firms, law firms, and public interest groups attended the workshop. Workshop panelists included the NRC staff as well as representatives from the Department of Energy (DOE), Department of Interior (DOI), Environmental Protection Agency (EPA), Council on Environmental Quality (CEQ), several State agencies, the nuclear industry, and public interest groups.

In February 1994, the NRC conducted three public meetings to solicit views on the NRC staff's options for addressing the need for generating capacity, alternative energy sources, economic costs, and cost-benefit analysis in the proposed rule. The intent to hold public meetings and the availability of the options paper was noticed in the Federal Register on January 12, 1994 (59 FR 2542). Written comments were also solicited on the options paper. The public meetings were held in Rockville, Maryland; Rosemont, Illinois; and Chicopee, Massachusetts.

Representatives from several States, the National Association of Regulatory Utility Commissioners (NARUC), the nuclear industry, and public interest groups actively participated. Nineteen separate written comments were also submitted, primarily by the States and the nuclear industry. In their submittals, the Nuclear Energy Institute (NEI), formerly known as the Nuclear Management and Resources Council (NUMARC), and Yankee Atomic Electric Company (YAEC) each proposed an approach to handling the issues of need for generating capacity and alternative energy sources in the rule. For the NRC staff to better understand these proposals, an additional public meeting was held with NEI and YAEC on May 16, 1994, in Rockville, Maryland.

After considering the public comments on the NRC staff's options paper, the NRC issued a proposed supplement to the proposed rule; it was published in the Federal Register on July 25, 1994 (59 FR 37724). The proposed supplement set forth the NRC staff's approach to the treatment of need for generating capacity and alternative energy sources, as well as the staff's revision to the purpose of and need for the proposed action (i.e., license renewal), which was intended to satisfy the States' concerns and to meet NEPA requirements. Twenty separate written comments were received in response to this solicitation from Federal and State agencies, the nuclear industry, a public interest group, and two private citizens.

B. Procedural Concerns

The commenters on the proposed rule raised significant concerns regarding the following procedural aspects of the rule:

(1) State and public participation in the license renewal process and the periodic assessment of the GEIS findings;

(2) The use of economic costs and cost-benefit balancing; and

(3) Consideration of the need for generating capacity and alternative energy sources in the environmental review of license renewal applications.

Each of these concerns and the NRC response is discussed below.

1. Public Participation and the Periodic Assessment of the Rule and the GEIS

Concern. Many commenters criticized the draft GEIS finding that 80 of 104 environmental issues could be generically applied to all plants and, therefore, would not be subject to plant-specific review at the time of license renewal. As a consequence, these commenters believe they are being denied the opportunity to participate in the license renewal process. Moreover, they pointed out that the site-specific nature of many important environmental issues does not justify a generic finding, particularly when the finding would have been made 20 years in advance of the decision to renew an operating license. The commenters believe that only a site-specific EIS to support a license renewal decision would satisfy NEPA requirements.

Federal and State agencies questioned how new scientific information could be folded into the GEIS findings because the GEIS would have been performed so far in advance of the actual renewal of an operating license. There were differing views on exactly how the NRC should address this question. A group of commenters, including CEQ and EPA, noted that the rigidity of the proposed rule hampers the NRC's ability to respond to new information or to different environmental issues not listed in the proposed rule. They believe that incorporation of new information can only be achieved through the process of amending the rules. One commenter recommended that, if the NRC decides to pursue the approach of making generic findings based on the GEIS, the frequency of review and update should be specifically stated in the rule. Recommendations on the frequency of the review ranged from 2 years to 5 years.

Response. In SECY–93–032, February 9, 1993, the NRC staff reported to the Commission their discussions with CEQ and EPA regarding the concerns these agencies raised, which were also raised by other commenters, about limiting public comment and the consideration of significant new information in individual license renewal environmental reviews. The focus of the commenters concerns is the limited nature of the site-specific reviews contemplated under the proposed rule. In response, the NRC has reviewed the generic conclusions in the draft rule, expanded the opportunity for site-specific review, and confirmed that what remains as generic is so. Also, the framework for consideration of significant new information has been revised and expanded.

The major changes adopted as a result of these discussions are as follows:

1. The NRC will prepare a supplemental site-specific EIS, rather than an environmental assessment (as initially proposed), for each license renewal application. This SEIS will be a supplement to the GEIS. Additionally, the NRC will review comments on the draft SEIS and determine whether such comments introduce new and significant information not considered in the GEIS analysis. All comments on the applicability of the analyses of impacts codified in the rule and the analysis contained in the draft supplemental EIS will be addressed by NRC in the final supplemental EIS in accordance with 40 CFR 1503.4, regardless of whether the comment is directed to impacts in Category 1 or 2. Such comments will be addressed in the following manner:

a. NRC's response to a comment regarding the applicability of the analysis of an impact codified in the rule to the plant in question may be a statement and explanation of its view that the analysis is adequate including, if applicable, consideration of the significance of new information. A commenter dissatisfied with such a response may file a petition for rulemaking under 10 CFR 2.802. If the commenter is successful in persuading the Commission that the new information does indicate that the analysis of an impact codified in the rule is incorrect in significant respects (either in general or with respect to the particular plant), a rulemaking proceeding will be initiated.

b. If a commenter provides new information which is relevant to the plant and is also relevant to other plants (i.e., generic information) and that information demonstrates that the analysis of an impact codified in the final rule is incorrect, the NRC staff will seek Commission approval to either suspend the application of the rule on a generic basis with respect to the analysis or delay granting the renewal application (and possibly other renewal applications) until the analysis in the GEIS is updated and the rule amended. If the rule is suspended for the analysis, each supplemental EIS would reflect the corrected analysis until such time as the rule is amended.

c. If a commenter provides new, site-specific information which demonstrates that the analysis of an impact codified in the rule is incorrect with respect to the particular plant, the NRC staff will seek Commission approval to waive the application of the rule with respect to that analysis in that specific renewal proceeding. The supplemental EIS would reflect the corrected analysis as appropriate.

2. The final rule and the GEIS will not include conditional cost-benefit conclusions or conclusions about alternatives. Conclusions relative to the overall environmental impacts including cumulative impacts will be left entirely to each site-specific SEIS.

3. After consideration of the changes from the proposed rule to the final rule and further review of the environmental issues, the NRC has concluded that it is

adequate to formally review the rule and the GEIS on a schedule that allows revisions, if required, every 10 years. The NRC believes that 10 years is a suitable period considering the extent of the review and the limited environmental impacts observed thus far, and given that the changes in the environment around nuclear power plants are gradual and predictable with respect to characteristics important to environmental impact analyses. This review will be initiated approximately 7 years after completion of the last cycle. The NRC will conduct this review to determine what, if anything, in the rule requires revision.

Concern. As part of their comments on the July 1994 Federal Register notice, NEI, several utilities, and the DOE asked that the NRC reconsider its understanding with CEQ and EPA regarding the preparation of a site-specific supplemental EIS for each license renewal action. These commenters supported an approach that would allow the preparation of an environmental assessment for reviewing the environmental impacts of license renewal.

Response. The NRC does not agree with this position. The NRC believes that it is reasonable to expect that an assessment of the full set of environmental impacts associated with an additional 20 years of operation of any plant would not result in a ''finding of no significant impact.'' Therefore, the review for any plant would involve an environmental impact statement.

2. Economic Costs and Cost-Benefit Balancing

Concern. State, Federal, and utility representatives expressed concern about the use of economic costs and cost-benefit balancing in the proposed rule and the draft GEIS. Commenters criticized the NRC's heavy emphasis on economic analysis and the use of economic decision criteria. They argued that the regulatory authority over utility economics falls within the States' jurisdiction and to some extent within the jurisdiction of the Federal Energy Regulatory Commission. Commenters also believe that the cost-benefit balancing used in the proposed rule and the draft GEIS went beyond NEPA requirements and CEQ regulations (40 CFR Parts 1500 to 1508). They noted that CEQ regulations interpret NEPA to require only an assessment of the cumulative effects of a proposed Federal action on the natural and man-made environment.

Response. In response to these concerns, the NRC has eliminated the use of cost-benefit analysis and consideration of utility economics in its NEPA review of a license renewal application except when such benefits and costs are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation. As discussed in more detail in the following section, the NRC recognizes that the determination of the economic viability of continuing the operation of a nuclear power plant is an issue that should be left to appropriate State regulatory and utility officials.

3. Need for Generating Capacity and Alternative Energy Sources

Concern. In their comments on the proposed rule and the draft GEIS, several States expressed concern that the NRC's analysis of need for generating capacity would preempt or prejudice State energy planning decisions. They argued that the determination of need for generating capacity has always been the States' responsibility. Recommendations on how to address this issue ranged from withdrawing the proposed rule to changing the categorization of the issue so that a site-specific review can be performed, thus allowing for meaningful State and public participation. Almost all the concerned States called on the NRC to modify the rule to state explicitly that NRC's analysis does not preempt a State's jurisdiction over the determination of need for generating capacity.

Regarding the issue of alternative energy sources, several commenters contended that the site-specific nature of the alternatives to license renewal did not justify the generic finding in the GEIS. One significant concern about this finding is the States' perception that a generic finding, in effect, preempts the States' responsibility to decide on the appropriate mix of energy alternatives in their respective jurisdictions.

Three regional public meetings were held during the February 1994 to discuss the concerns of the States. At these meetings, and later in written comments, the State of New York proposed an approach to resolve the problem. The approach was endorsed by several other States. This approach had three major conditions:

(1) A statement in the rule that the NRC's findings on need and alternatives are only intended to satisfy the NEPA requirements and do not preclude the States from making their own determination with respect to these issues;

(2) The designation of the need for generating capacity and alternative energy sources as Category 3 (i.e., requiring site-specific evaluation); and

(3) A requirement that all site-specific EISs and relicensing decisions reference State determinations of need for generating capacity and alternative energy sources, and that they defer to those State determinations to the maximum extent possible.

Response. After consideration, the NRC staff did not accept all elements of the States' approach because the approach would have continued to require the NRC to consider the need for generating capacity and utility economics as part of its environmental analysis. In addition, the approach would have required the NRC to develop guidelines for determining the acceptability of State economic analyses, which some States may have viewed as an intrusion on their planning process.

The NRC staff developed and recommended another approach, which was published on July 25, 1994 (59 FR 37724), after consideration of information gathered at the regional meetings and from the written comments. This approach, which borrows some elements from NEI and YAEC proposals, has five major features:

(1) Neither the rule nor the GEIS would contain a consideration of the need for generating capacity or other issues involving the economic costs and benefits of license renewal and of the associated alternatives;

(2) The purpose and need for the proposed action (i.e., license renewal) would be defined as preserving the continued operation of a nuclear power plant as a safe option that State regulators and utility officials may consider in their future planning actions;

(3) The only alternative to the proposed action would be the ''no-action'' alternative, and the environmental consequences of this alternative are the impacts of a range of energy sources that might be used if a nuclear power plant operating license were not renewed;

(4) The environmental review for license renewal would include a comparison of the environmental impacts of license renewal with impacts of the range of energy sources that may be chosen in the case of ''no action''; and

(5) The NRC's NEPA decision standard for license renewal would require the NRC to determine whether the environmental impacts of license renewal are so great that preserving the option of license renewal for future decisionmakers would be unreasonable.

The statement that the use of economic costs will be eliminated in this approach refers to the ultimate NEPA decision regarding the comparison of alternatives and the proposed action. This approach does not preclude a consideration of economic costs if these costs are essential to a determination regarding the inclusion of an alternative in the range of alternatives considered (i.e., an alternative's exorbitant cost could render it nonviable and unworthy of further consideration) or relevant to mitigation of environmental impacts. Also, the two local tax issues and the two economic structure issues under socioeconomics in the table would be removed from consideration when applying the decision standard.

Concern. Comments received from several States on the NRC staff's July 1994 recommended approach ranged from rejection to endorsement. Some States supported the three conditions proposed by the State of New York. Several States were still concerned about whether a meaningful analysis of need for generating capacity and alternative energy sources could be undertaken 20 years ahead of time. One State asked that the proposed rule be withdrawn. Another State wanted the proposed rule to be reissued for public comment. CEQ supported the approach proposed by the State of New York. CEQ believed that the NRC's recommended approach was in conflict with the NEPA process because the proposed statement of purpose and need for the proposed action was too narrow and did not provide for an appropriate range of alternatives to the underlying need for the proposed action. CEQ wanted the NRC to address other energy sources as separate alternatives, rather than as consequences of the no-action alternative. Moreover, CEQ stated that the proposed decision standard places a "weighty and improper burden of proof" on consideration of the alternative. The EPA endorsed CEQ's comments. In general, the nuclear industry was supportive of the recommended approach. However, NEI and the utilities strongly expressed the opinion that, with the redefined statement of purpose and need, alternative energy sources would no longer be alternatives to the proposed action and, therefore, need not be considered.

Response. After consideration of the comments received on the Commission's July 1994 proposal, the Commission has modified and clarified its approach in order to address the concerns of CEQ relative to consideration of appropriate alternatives and the narrow definition of purpose and need. These modifications and clarifications addressed the States' concerns relative to treatment of need for generating capacity and alternatives. Specifically, the Commission has clarified the purpose and need for license renewal in the GEIS as follows:

> The purpose and need for the proposed action (renewal of an operating license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized, Federal (other than NRC) decisionmakers.

Using this definition of the purpose of and need for the proposed action, which stresses options for the generation of power, the environmental review will include a characterization of alternative energy sources as being the alternatives to license renewal and not merely the consequences of the no-action alternative and, thus, it addresses CEQ's concern that the scope of the alternatives analysis is unacceptably restricted.

With respect to the States' concerns regarding need for generating capacity analysis, the NRC will neither perform analyses of the need for power nor draw any conclusions about the need for generating capacity in a license renewal review. This definition of purpose and need reflects the Commission's recognition that, absent findings in the safety review required by the Atomic Energy Act of 1954, as amended, or in the NEPA environmental analysis that would lead the NRC to reject a license renewal application, the NRC has no role in the energy planning decisions of State regulators and utility officials. From the perspective of the licensee and the State regulatory authority, the purpose of renewing an operating license is to maintain the availability of the nuclear plant to meet system energy requirements beyond the term of the plant's current license. The underlying need that will be met by the continued availability of the nuclear plant is defined by various operational and investment objectives of the licensee. Each of these objectives may be dictated by State regulatory requirements or strongly influenced by State energy policy and programs. In cases of interstate generation or other special circumstances, Federal agencies such as the Federal Energy Regulatory Commission (FERC) or the Tennessee Valley Authority (TVA) may be involved in making these decisions. The objectives of the various entities involved may include lower energy cost, increased efficiency of energy production and use, reliability in the generation and distribution of electric power, improved fuel diversity within the State, and environmental objectives such as improved air quality and minimized land use.

The consideration of alternatives has been shifted to the site-specific review. The rule contains no information or conclusions regarding the environmental impacts of alternative energy sources, it only indicates that the environmental impact of alternatives will be considered during the individual plant review. However, the GEIS contains a discussion of the environmental impacts of alternative energy sources based on currently available information. The information in the GEIS is available for use by the NRC and the licensee in performing the site-specific analysis of alternatives and will be updated as appropriate. For individual plant reviews, information codified in the rule, information developed in the GEIS, and any significant new information introduced during the plant-specific review, including any information received from the State, will be considered in reaching conclusions in the supplemental EIS. The NRC's site-specific comparison of the impacts of license renewal with impacts of alternative energy sources will involve consideration of information provided by State agencies and other members of the public. This approach should satisfy the States' concerns relative to a meaningful analysis of alternative energy sources.

The Commission disagrees with CEQ's assertion that the new decision standard is inappropriate. Under this decision standard, the NRC must determine if the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable. The Commission expects that license renewal would be denied only if the expected environmental effects of license renewal significantly exceed all or almost all alternatives. The Commission believes that this is a reasonable approach to addressing the issue of environmental impacts of license renewal, given NRC's limited role in the area of energy systems planning. The operation of a nuclear power plant beyond its initial license term involves separate regulatory actions, one taken by the utility and the NRC, and the other taken by the utility and the State regulatory authorities. The decision standard would be used by NRC to determine whether, from an environmental perspective, it is reasonable to renew the operating license and allow State and utility decisionmakers the option of considering a currently operating nuclear power plant as an alternative for meeting future energy needs. The test of reasonableness focuses on an analysis of whether the environmental impacts anticipated for continued operation during the term of the renewed license reasonably compare with the impacts that are expected from the set of alternatives considered for meeting generating requirements. The NRC would reject a license renewal application if the analysis demonstrated that the adverse environmental impacts of the individual license renewal were so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable.

After the NRC makes its decision based on the safety and environmental considerations, the final decision on whether or not to continue operating the nuclear plant will be made by the utility, State, and Federal (non-NRC) decisionmakers. This final decision will be based on economics, energy reliability goals, and other objectives over which the other entities may have jurisdiction. The NRC has no authority or regulatory control over the ultimate selection of future energy alternatives. Likewise, the NRC has no regulatory power to ensure that environmentally superior energy alternatives are used in the future. Given the absence of the NRC's authority in the general area of energy planning, the NRC's rejection of a license renewal application based on the existence of a single superior alternative does not guarantee that such an alternative will be used. In fact, it is conceivable that the rejection of a license renewal application by the NRC in favor of an individual alternative may lead to the implementation of another alternative that has even greater environmental impacts than the proposed action, license renewal.

Given the uncertainties involved and the lack of control that the NRC has in the choice of energy alternatives in the future, the Commission believes that it is reasonable to exercise its NEPA authority to reject license renewal applications only when it has determined that the impacts of license renewal sufficiently exceed the impacts of all or almost all of the alternatives that preserving the option of license renewal for future decision makers would be unreasonable. Because the objectives of the utility and State decisionmakers will ultimately be the determining factors in whether a nuclear power plant will continue to operate, NRC's proposed decision standard is appropriate. The decision standard will not affect the scope or rigor of NRC's analyses, including the consideration of the environmental impacts relevant to the license renewal decision and associated alternatives. The NRC staff believes that, under the circumstances, the decision standard does not place ''a weighty and improper burden of proof'' on other alternatives as CEQ claims.

With respect to the industry's desire to eliminate consideration of alternative energy sources, the Commission does not agree. The Commission does not support the views of NEI and others that alternative energy sources need not be considered in the environmental review for license renewal. The Commission is not prepared to state that no nuclear power plant will fall well outside the range of other reasonably available alternatives far in advance of an actual relicensing decision. Following NEI's suggestion would not lead to a meaningful set of alternatives with which to compare a proposed action. The Commission has always held the view that alternative sources of energy should be compared with license renewal and continued operation of a nuclear power plant.

Lastly, the Commission does not believe it is necessary to reissue this rule for public comment as a State commenter requested. The Commission has taken many measures to involve the public concerning the resolution of public comments on the proposed rule. The Commission has conducted a number of public meetings and published for public comment its recommended procedural revisions to the proposed rule. The Commission believes that modifications made to the proposed rule reflect the logical outgrowth of the proposed rule based on the public comments received by the Commission.

C. Technical Concerns

1. Category and Impact Magnitude Definitions

Concerns. Many commenters expressed concern that the category definitions and the impact-significance definitions were ambiguous and appeared somewhat interconnected. The EPA expressed concern that mitigation of adverse impacts was not addressed adequately.

Commenters expressed a number of concerns about the use of the applicability categories and the magnitude-level categories. With respect to the applicability categories, concerns ranged from a general concern that Category 1 precludes or hinders public involvement in an issue at the time of the plant-specific review to specific concerns about the technical adequacy of the analysis supporting a Category 1 finding for an issue. Several commenters believed that the definitions create confusion, especially as to whether the finding of small impact and Category 1 are interdependent. The GEIS appears to use Category 1 and ''small'' interchangeably. Concern was also expressed that the requirement to consider mitigative actions was inadequately addressed in the draft GEIS and proposed rule.

Response. To reduce potential confusion over the definitions, the use of the categories, and the treatment of mitigation within the context of the categorization scheme, the NRC has revised the definitions to eliminate any ambiguity as to how they are used. Further, the GEIS has been modified to clearly state the reasons behind the category and magnitude findings.

In order to facilitate understanding of the modifications to the GEIS, the previous approach is discussed as follows. In the proposed rule and the draft GEIS, findings about the environmental impact associated with each issue were divided into three categories of applicability to individual plant reviews. These categories were:

- Category 1: A generic conclusion on the impact has been reached for all affected nuclear power plants.
- Category 2: A generic conclusion on the impact has been reached for affected nuclear power plants that fall within defined bounds.
- Category 3: A generic conclusion on the impact was not reached for any affected nuclear power plants.

The significance of the magnitude of the impact for each issue was expressed as one of the three following levels.

- *Small* impacts are so minor that they warrant neither detailed investigation nor consideration of mitigative actions when such impacts are negative.
- *Moderate* impacts are likely to be clearly evident and usually warrant consideration of mitigation alternatives when such impacts are negative.
- *Large* impacts involve either a severe penalty or a major benefit, and mitigation alternatives are always considered when such impacts are negative.

With respect to the categories of applicability, under the proposed rule applicants would have:

(1) Not provided additional analyses of Category 1 issues;

(2) Not provided additional analyses if their plant falls within the bounds

defined in the rule for a Category 2 issue;

(3) Provided additional plant-specific analyses if their plant does not fall within the bounds defined in the rule for a Category 2 issue; and

(4) Provided plant-specific analyses of Category 3 issues.

In order to address the comments on these magnitude and category definitions, the GEIS has been modified to clearly state the reasons behind the category and magnitude findings.

The revised definitions are listed below.

• Category 1: For the issue, the analysis reported in the Generic Environmental Impact Statement has shown:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic;

(2) A single significance level (i.e., small, moderate, or large) has been assigned to the impacts (except for collective off site radiological impacts from the fuel cycle and from high level waste and spent fuel disposal); and

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

The generic analysis of the issue may be adopted in each plant-specific review. Issues for which the impact was found to be favorable were also defined to be Category 1 issues.

• Category 2: For the issue, the analysis reported in the GEIS has shown that one or more of the criteria of Category 1 cannot be met and, therefore, additional plant-specific review is required.

If, for an environmental issue, the three Category 1 criteria apply to all plants, that issue is Category 1 and the generic analysis should be used in a license renewal review for all plant applications. If the three Category 1 criteria apply to a subset of plants that are readily defined by a common plant characteristic, notably the type of cooling system, the population of plants is partitioned into the set of plants with the characteristic and the set without the characteristic. For the set of plants with the characteristic, the issue is Category 1 and the generic analysis should be used in the license renewal review for those plants. For the set of plants without the characteristic, the issue is Category 2 and a site-specific analysis for that issue will be performed as part of the license renewal review. The review of a Category 2 issue may focus on the particular aspect of the issue that causes the Category 1 criteria not to be met. For example, severe accident mitigation under the issue ''severe accidents'' is the focus for a plant-specific review because the other aspects of the issue, specifically the offsite consequences, have been adequately addressed in the GEIS. With the revised definitions, the two issues previously designated as Category 3 are now designated Category 2. For an issue to be a Category 1, current mitigation practices and the nature of the impact were considered and a determination was made that it is unlikely that additional measures will be sufficiently beneficial. In the GEIS, in discussing the impacts for each issue, consideration was given to what is known about current mitigation practices.

The definitions of the significance level of an environmental impact have been revised to make the consideration of the potential for mitigating an impact separate from the analysis leading to a conclusion about the significance level of the impact. Further, the significance level of an impact is now more clearly tied to sustaining specific attributes of the affected resource that are important to its viability, health or usefulness. General definitions of small, moderate and large significance levels are given below. These definitions are adapted to accommodate the resource attributes of importance for each of the environmental issues in the GEIS. The definition of ''small'' clarifies the meaning of the term as it applies to radiological impacts. The definition of ''small'' in the proposed rule did not logically apply to such impacts.

The general definitions of significance level are:

• Small: For the issue, environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered small.

• Moderate: For the issue, environmental effects are sufficient to alter noticeably but not to destabilize important attributes of the resource.

• Large: For the issue, environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The discussion of each environmental issue in the GEIS includes an explanation of how the significance category was determined. For issues in which probability of occurrence is a key consideration (i.e., accident consequences), the probability of occurrence has been factored into the determination of significance. The determination of the significance category was made independently of the consideration of the potential benefit of additional mitigation.

The major concerns (organized by topical areas) about the environmental issues examined in the draft GEIS and the NRC staff's response to those concerns are summarized next.

2. Surface Water Quality

Concern. Several commenters expressed concerns related to the National Pollutant Discharge Elimination System (NPDES) permitting process for surface water discharge. They believe that the NRC may have overlooked its legal obligation to comply with Section 401 of the Clean Water Act (CWA). Their recommendations included withholding approval for license renewal until a facility has complied with Section 401 and treating license renewal as an opportunity for a new NEPA review. On the other hand, other commenters recommended decoupling the NRC relicensing process from the NPDES permitting process.

Response. In issuing individual license renewals, the Commission will comply, as has been its practice, with the provisions of Section 401 of the Federal Water Pollution Control Act (see 10 CFR 51.45(d) and 51.71(c)). In addition, pursuant to Section 511(c) of the Federal Water Pollution Control Act of 1972, the Commission cannot question or reexamine the effluent limitations or other requirements in permits issued by the relevant permitting authorities. Nevertheless, compliance with the environmental quality standards and requirements of these permits does not negate the requirement for the Commission to consider all environmental effects of the proposed action. Accordingly, the Commission has not only taken existing permits into account in its analysis of the water quality impacts of license renewal but has also considered information on actual operating impacts collected from individual plants, State and Federal regulatory agencies, and published literature. As a result of this analysis, the Commission has concluded that the environmental impacts on surface water quality are small for those effluents subject to existing permit or certification requirements. A total decoupling of the license renewal process and the NPDES permitting process is not appropriate because, for issues with incomplete Clean Water Act determinations, the NRC cannot complete its weighing and balancing of impacts without independently addressing the issues.

Concern. Several commenters raised concerns that various issues within the Surface Water Quality topic should be Category 2 or 3 issues. These included water use conflicts as experienced in Arizona and the Midwest, thermal stratification and salinity gradients associated with once-through cooling systems, and the toxicity of biofouling compounds.

Response. Regarding the water use conflicts, the NRC has considered the impacts of water use during the renewal period and has concluded that these impacts are small for plants with a once-through cooling system and that this is a Category 1 issue for those plants. However, this issue is designated Category 2 for plants with cooling towers and cooling ponds because, for those plants, the impacts might be moderate (they could also be small). In either case, pursuant to 10 CFR 51.45(d), an applicant for license renewal must identify and indicate in its environmental report the status of State and local approvals regarding water use issues. For those reactor sites where thermal stratification or salinity gradient was found to be the most pronounced, the issues were reviewed during preparation of the GEIS and found to be acceptable by the States within the NPDES process. No change in the categorization in the GEIS would be required. Similarly, the NPDES permit for a facility establishes allowable discharges, including biocides. The NRC has no indication that residual environmental impacts would occur as a result of license renewal activities at any nuclear plant site other than perhaps water use conflicts arising at plants with cooling ponds or cooling towers using make-up water from a small river with low flow. For those plants, this issue is Category 2.

3. Aquatic Ecology

Concern. A number of comments regarding the ecological impact of cooling water withdrawal from aquatic bodies were received. Specific concerns included fish kills associated with the entrainment and impingement of fish within once-through and cooling pond cooling systems, the use of chlorine and molluscicides to control mussel and clam growth, and the long-term effects of heavy metal discharges from plants with copper-nickel condenser tubes. Another commenter noted that license extension affords the opportunity to review the intake and discharge configuration of plant cooling water systems, since the best available technology that is economically available may be different given the additional 20 years of plant operating life.

Response. The Commission has considered the impacts of license renewal on aquatic ecology and, in doing so, has reviewed existing NPDES permits and other information. Based on this analysis, the Commission has concluded that these impacts are small with the exception that plants with once-through cooling and cooling ponds may have larger effects associated with entrainment of fish and shellfish in early life stages, impingement, and heat shock. Agencies responsible for existing permits are not constrained from reexamining the permit issues if they have reason to believe that the basis for their issuance is no longer valid. The Commission does not have authority under NEPA to impose an effluent limitation other than those established in permits issued pursuant to the Clean Water Act. The problem of the long-term effects of heavy metal discharges from plants with copper-nickel condenser tubes has been found at only one plant. The affected condenser tubes have been replaced with tubing of a more corrosion-resistant material.

Concern. A commenter pointed out that the issue of riparian zones should be addressed in the GEIS because the vegetation region along a water course can be affected by water withdrawal and is important in maintaining the habitat.

Response. The NRC agrees with the importance of addressing the impacts of license renewal on the riparian habitat. The final GEIS provides a discussion of the riparian habitat as an important resource and the potential effects of consumptive water use on riparian zones.

4. Groundwater Use and Quality

Concern. Several commenters indicated that groundwater issues should be reviewed on a site-specific basis because of groundwater use conflicts (in particular, the effect on aquifer recharge of using surface water for cooling water), opportunities for saltwater intrusion, and concerns over tritium found in wells at one site. On the other hand, a commenter requested that the issue of groundwater use for cooling tower makeup water be changed from Category 2 to Category 1 because the issue is based solely on data from Ranney wells at the Grand Gulf Nuclear Station, where tests have shown that the elevation of the water plain around Grand Gulf is not dropping.

Response. Based on consideration of comments, the issue of groundwater use conflicts resulting from surface water withdrawals for cooling tower makeup water or cooling ponds is now Category 2 for plants withdrawing surface water from small water bodies during low flow conditions. The GEIS has identified a potential reduction in aquifer recharge as a result of competing water use. These conflicts are already a concern at two closed-cycle nuclear power plants. The NRC does not agree that saltwater intrusion should be considered a Category 2 issue. When saltwater intrusion has been a problem, the major cause has been the large consumption of groundwater by agricultural and municipal users. Groundwater consumption by nuclear power plants is small by comparison and does not contribute significantly to the saltwater intrusion problem. With regard to traces of tritium found in the groundwater at one nuclear power plant, the tritium was attributed to a modification in the plant's inlet and discharge canal that did not take into consideration a unique situation in topology and groundwater flow. The releases were minor and the situation has been corrected.

Regarding the issue of the use of groundwater for cooling water makeup, the NRC has designated this issue as Category 2 even though only the Grand Gulf Nuclear Station is currently using Ranney wells to withdraw groundwater. This water intake does not conflict with other groundwater uses in the area. It is not possible to predict whether or not water use conflicts will occur at the Grand Gulf facility in the future. It is also not possible to determine the significance of the environmental impacts associated with Ranney well use at other nuclear plants that may choose to adopt this method in the future.

5. Terrestrial Ecology

Concern. Several commenters recommended that the issue of bird mortality resulting from collisions with transmission lines, towers, or cooling towers be characterized as a Category 2 issue. Such a characterization would provide for a review of mitigation at those plants with cooling towers that do not have illumination and for power plant transmission lines that transect major flyways or that cross wetlands used by large concentrations of birds.

Response. The NRC does not agree with this recommendation. The GEIS cites several studies that conclude that bird mortalities resulting from collision with transmission lines, towers, or cooling towers are not significantly reducing bird populations. Mitigation measures in place, such as safety lights, were found adequate and additional measures were not warranted. Therefore, the issue remains a Category 1 issue because refurbishment will not involve construction of any additional transmission lines or natural draft cooling towers.

Concern. One commenter expressed concern that the GEIS analysis of land use did not adequately encompass the impact of onsite spent fuel storage on land use and that the Category 1 finding is questionable. A specific concern was the potential need for the construction of additional spent fuel storage facilities associated with the license renewal term, along with their associated impacts on the terrestrial environment.

Response. The NRC does not agree that there is a need to change the Category 1 determination for onsite land use. Waste management operations could require the construction of additional storage facilities and thus adversely affect land use and terrestrial ecology. However, experience has shown that the land requirements would be relatively small (less than 9 acres), impacts to land use and terrestrial ecology would also be relatively small, and the land that may be used is already possessed by the applicant; thus, its basic use would not be altered. Onsite land use is Category 1. Terrestrial ecology with disturbance of sensitive habitat is treated as a separate issue and is Category 2.

6. Human Health

Concern. In the human health section of the GEIS, the radiological impacts of plant refurbishment and continued operations during the license renewal term to workers and the general public were examined. Several commenters indicated that it was inappropriate to compare the radiation exposures associated with license renewal to natural background levels. These commenters believed that the appropriate argument should be that the risks associated with the additional exposures are so small that no additional mitigative measures are required.

Response. The NRC agrees that the assessment of radiation exposure should not be simply a comparison with background radiation. In response to comments on the draft generic environmental impact statement and the proposed rule, the standard defining a small radiological impact has changed from a comparison with background radiation to sustained compliance with the dose and release limits applicable to the various stages of the fuel cycle. This change is appropriate and strengthens the criterion used to define a small environmental impact for the reasons that follow. The Atomic Energy Act requires the Nuclear Regulatory Commission to promulgate, inspect and enforce standards that provide an adequate level of protection of the public health and safety and the environment. The implementation of these regulatory programs provides a margin of safety. A review of the regulatory requirements and the performance of facilities provides the bases to project continuation of performance within regulatory standards. For the purposes of assessing radiological impacts, the Commission has concluded that impacts are of small significance if doses to individuals and releases do not exceed the permissible levels in the Commission's regulations.

With respect to whether additional mitigative measures are required, it should be noted that in 10 CFR parts 20 and 50 there are provisions that radiological impacts associated with plant operation be reduced to levels as low as reasonably achievable (ALARA).

Concern. Several commenters indicated that the GEIS needs a broader treatment of uncertainty as it relates to human health issues.

Response. The NRC agrees that there is considerable uncertainty associated with health effects, especially at low occupational and public dose levels, and particularly with respect to electromagnetic fields. Health effect estimates from radiation exposures are based on the best scientific evidence available and are considered to be conservative estimates. Several sections of the GEIS have been expanded to more thoroughly explain how predicted impacts could be affected by changes in scientific information or standards.

Concern. One commenter indicated that, in the GEIS and the proposed rule, risk coefficients should have been used for chemicals and radiation to obtain upper bound risk estimates of cancer incidence.

Response. The NRC does not agree with this comment. In making comparisons of alternatives, comparisons of the central or best estimates of impacts are consistent with NEPA requirements because they provide the fairest determination. The GEIS is written using current, Commission-approved risk estimators.

Concern. Two commenters expressed concern regarding the GEIS conclusion that the impact of radiation exposure to the public is small, citing a study done by the Massachusetts Department of Public Health (MDPH). This study concluded that adults who live within 10 miles of the Pilgrim Nuclear Power Plant have a risk of contracting leukemia four times greater than other individuals.

Response. The NRC staff reviewed the MDHP study and compared it with various other studies. The results of the study have been contradicted by a National Cancer Institute (NCI) study entitled ''Cancer in Populations Living Near Nuclear Facilities'' (July 1990). The NCI study, which included the Pilgrim plant in its analysis, found no reason to suggest that nuclear facilities may be linked causally with excess deaths from leukemia or from other cancers. The findings of the NCI study are consistent with the findings of several similar epidemiological studies in foreign countries and with the latest conclusions of expert bodies such as the National Research Council's Committee on the Biological Effects of Ionizing Radiation. The NRC continues to base its assessment of the health effects of ionizing radiation on the overall body of scientific knowledge and on the recommendations of expert groups.

7. Socioeconomics

Concern. A commenter concerned with historic preservation pointed out that this issue must be addressed through compliance with the National Historic Preservation Act (NHPA) and cannot be resolved generically.

Response. The NRC agrees with this comment. Historical and archaeological impacts have been changed from a Category 1 to a Category 2 issue (that is, it must be evaluated site-specifically). Consultation with State historical preservation offices and other Government agencies, as required by NHPA, must be undertaken to determine whether protected historical or archaeological resources are in areas that might be disturbed during refurbishment activities and operation during the renewal period.

Concern. Several commenters indicated that transportation issues associated with refurbishment activities should be changed from Category 3 to Category 2 because the impacts will be insignificant in the majority of cases. One recommendation was to use a level of service (LOS) determination for specific plants as the bounding criterion. The analysis would require that LOS be determined for that part of the refurbishment period during which traffic not related to the plant is expected to be the heaviest. Another recommendation was to establish bounding criteria based on past major routine outages.

Response. The NRC agrees that use of the LOS approach may prove to be acceptable. Transportation still must be reviewed on a plant-specific basis, that is, it is a Category 2 issue (based on the revised definition).

Concern. There were recommendations to make the housing impacts during refurbishment a Category 1 issue instead of Category 2. One commenter noted that the construction period data used in the analysis appears to overestimate the impact on housing.

Response. The NRC does not agree that this should be a Category 1 issue. Although negligible housing impacts are anticipated for most license renewals, significant housing impacts have occurred during a periodic plant outage at one of the case plants studied for the analysis. This issue is now a Category 2 issue because moderate and large impacts on housing are possible depending on local conditions (e.g., areas with extremely slow population growth or areas with growth control measures that limit housing development).

8. The Uranium Fuel Cycle and Solid Waste Management

Concern. Wide-ranging concerns were expressed in the comments on the proposed rule and the draft GEIS about the treatment of storage and disposal of low-level waste (LLW), mixed waste, spent fuel, nonradiological waste, and the transportation of fuel and waste to and from nuclear power plants as a consequence of license renewal. Concern was expressed about the uncertain availability of disposal facilities for LLW, mixed waste, and spent fuel; the prospect of generation and onsite storage of an additional 20 years output of waste; and the resulting pressure that would be put on the States to provide LLW disposal facilities. Various commenters expressed concern about the adequacy of the treatment of the cost of waste management and the implications for the economic viability of license renewal. Numerous comments were provided on updating and clarifying data on waste management presented in the draft GEIS. Finally, various questions were raised about the applicability of Table S–3 (10 CFR 51.51 Uranium fuel cycle environmental data—Table S–3, Table of Uranium Fuel Cycle Environmental Data) to the management of waste generated as a result of license renewal.

With regard to spent fuel, several commenters expressed concern that dry cask storage is not a proven technology and that onsite storage of spent fuel from an additional 20 years of plant operation will present environmental and safety problems. Therefore, onsite storage of spent fuel should be considered on a site-specific basis within a plant license renewal review.

Response. The Commission acknowledges that there is uncertainty in the schedule of availability of disposal facilities for LLW, mixed waste, and spent fuel. However, the Commission believes that there is sufficient understanding of and experience with the storage of LLW, mixed waste, and spent fuel to conclude that the waste generated at any plant as a result of license renewal can be stored safely and without significant environmental impacts before permanent disposal. In addition, the Commission concluded that the classification of storage and ultimate disposal as a Category 1 issue is appropriate because States are proceeding, albeit slowly, with the development of new disposal facilities; LLW and mixed waste have been and can be safely stored at reactor sites until new disposal capacity becomes available. Analyses to support this conclusion are presented in Chapter 6 of the final GEIS (NUREG–1437). The following summary of the responses to comments emphasizes the main features of these analyses.

In the draft GEIS, the environmental data in Table S–3 were discussed with respect to applicability during the license renewal period and supplemented with an analysis of the radiological release and dose commitment data for radon-222 and technetium-99. The proposed rule would have had this discussion apply to each plant at the time of its review for license renewal.

Further, in the draft GEIS, Chapter 6, ''Solid Waste Management,'' covered the generation of LLW, mixed waste, spent fuel, and nonradiological waste as a result of license renewal; the transportation of the radiological waste; and the environmental impacts of waste management, including storage and disposal. The findings that were to have been codified in the rule were that, for nonradiological waste, mixed waste, spent fuel, and transportation, the environmental impacts are of small significance and that the analysis in the GEIS applies to each plant (Category 1). For LLW, the finding that would have been codified in the rule was that, if an applicant does not have access to a low-level radioactive waste disposal facility through a low-level waste compact or an unaffiliated State, the applicant must present plans for interim waste storage with an assessment of potential ecological habitat destruction caused by construction activities (Category 2).

In response to the questions about the applicability of Table S–3 to the management of waste associated with license renewal and to the various comments challenging the treatment of the several forms of waste in the draft GEIS and in the proposed rule, the discussion of Table S–3 has been moved from Section 4.8 of the draft GEIS to Chapter 6 of the final GEIS in order to provide a more integrated assessment of the environmental impacts associated with waste management as a consequence of license renewal. Also in response to various comments, the discussion of Table S–3 and of each of the types of waste has been expanded.

Supplemental data are presented in Chapter 6 of the final GEIS in order to extend the coverage of the environmental impacts of the uranium fuel cycle presented in the current Table S–3 and of transportation of radioactive waste presented in the current Table S–4 to radon-222, technetium-99, higher fuel enrichment, and higher fuel burnup. In part, the current Table S–3 and the data supplementing it cover environmental impacts of:

(1) Onsite storage of spent fuel assemblies in pools for 10 years, packaging and transportation to a Federal repository, and permanent disposal; and

(2) Short-term storage onsite of LLW, packaging and transportation to a land-burial facility, and permanent disposal.

The following conclusions have been drawn with regard to the environmental impacts associated with the uranium fuel cycle.

The radiological and nonradiological environmental impacts of the uranium fuel cycle have been reviewed. The review included a discussion of the values presented in Table S–3, an assessment of the release and impact of ^{222}Rn and of ^{99}Tc, and a review of the regulatory standards and experience of fuel cycle facilities. For the purpose of assessing the radiological impacts of license renewal the Commission uses the standard that the impacts are of small significance if doses and releases do not exceed permissible levels in the Commission's regulations. Given the available information regarding the compliance of fuel cycle facilities with applicable regulatory requirements, the Commission has concluded that, other than for the disposal of spent fuel and high-level waste, these impacts on individuals from radioactive gaseous and liquid releases will remain at or below the Commission's regulatory limits. Accordingly, the Commission concludes that offsite radiological impacts of the fuel cycle (individual effects from other than the disposal of spent fuel and high-level waste) are small. ALARA efforts will continue to apply to fuel cycle activities. This is a Category 1 issue.

The radiological impacts of the uranium fuel cycle on human populations over time (collective effects) have been considered within the framework of Table S–3. The 100 year environmental dose commitment to the U.S. population from the fuel cycle, high level waste and spent fuel disposal excepted, is calculated to be about 14,800 man-rem, or 12 cancer fatalities, for each additional 20 year power reactor operating term. Much of this, especially the contribution of radon releases from mines and tailing piles, consists of tiny doses summed over large populations. This same dose calculation can theoretically be extended to include many tiny doses over additional thousands of years as well as doses outside the U.S. The result of such a calculation would be thousands of cancer fatalities from the fuel cycle, but this result assumes that even tiny doses have some statistical adverse health effect which will not ever be mitigated (for example no cancer cure in the next thousand years), and that these dose projections over thousands of years are meaningful. However these assumptions are questionable. In particular, science cannot rule out the possibility that there will be no cancer fatalities from these tiny doses. For perspective, the doses are very small fractions of regulatory limits, and even smaller fractions of natural background exposure to the same populations. No standards exist that can be used to reach a conclusion as to the significance of the magnitude of the collective radiological effects. Nevertheless, some judgement as to the regulatory NEPA implication of this issue should be made and it makes no sense to repeat the same judgement in every case. The Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the collective effects of the fuel cycle, this issue is considered Category 1. For other Category 1 issues, the impacts will be considered at the individual renewal stage as a means of judging the total impact of an individual license renewal decision. However, the Commission has already judged the impact of collective effects of the fuel cycle as part of this rule.

There are no current regulatory limits for off-site releases of radionuclides for the current candidate repository site. However if we assume that limits are developed along the lines of the 1995 National Academy of Sciences (NAS) report, and that in accordance with the Commission's Waste Confidence Decision, a repository can and likely will be developed at some site which will comply with such limits, peak doses to virtually all individuals will be 100 millirem per year or less. However, while the Commission has reasonable confidence that these assumptions will prove correct there is considerable uncertainty since the limits are yet to be developed, no repository application has been completed or reviewed, and uncertainty is inherent in the models used to evaluate possible pathways to the human environment. The National Academy report indicated that 100 millirem per year should be considered as a starting point for limits for individual doses, but notes that some measure of consensus exists among national and international bodies that the limits should be a fraction of the 100 millirem per year. The lifetime individual risk from 100 millirem per year dose limit is about 3×10^{-3}. Doses to populations from disposal cannot now (or possibly ever) be estimated without very great uncertainty. Estimating cumulative doses to populations over thousands of years is more problematic. The likelihood and consequences of events that could seriously compromise the integrity of a deep geologic repository were evaluated by the Department of Energy in the ''Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste,'' October 1980. The evaluation estimated the 70-year whole-body dose commitment to the maximum individual and to the regional population resulting from several modes of breaching a reference repository in the year of closure, after 1,000 years, after 100,000 years, and after 100,000,000 years. The release scenarios covered a wide range of consequences from the limited consequences of humans accidentally drilling into a waste package in the repository to the catastrophic release of the repository inventory by a direct meteor strike. Subsequently, the NRC and other Federal agencies have expended considerable effort to develop models for the design and for the licensing of a high level waste repository, especially for the candidate repository at Yucca Mountain. More meaningful estimates of doses to population may be possible in the future as more is understood about the performance of the proposed Yucca Mountain repository. Such estimates would involve very great uncertainty, especially with respect to cumulative population doses over thousands of years. The standard proposed by the NAS is a limit on maximum individual dose. The relationship of potential new regulatory requirements, based on the NAS report, and cumulative population impacts has not been determined, although the report articulates the view that protection of individuals will adequately protect the population for a repository at Yucca Mountain. However, EPA's generic repository standards in 40 CFR part 191 generally provide an indication of the order of magnitude of cumulative risk to population that could result from the licensing of a Yucca Mountain repository, assuming the ultimate standards will be within the range of standards now under consideration. The standard in 40 CFR part 191 protects the population by imposing ''containment requirements'' that limit the cumulative amount of radioactive material released over 10,000 years. The cumulative release limits are based on EPA's population impact goal of 1,000 premature cancer deaths world-wide for a 100,000 metric tonne (MTHM) repository.

Nevertheless, despite all the uncertainty surrounding the effects of the disposal of spent fuel and high-level waste, some judgement as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent fuel and high-level waste disposal, this issue is considered Category 1. Excepting the collective effects previously discussed, for other Category 1 issues, the impacts will be considered at the individual renewal stage as a means of judging the total impact of an individual license renewal decision. However, the Commission has already judged the impacts of high level waste disposal as part of this rule.

With respect to the nonradiological impact of the uranium fuel cycle, data concerning land requirements, water requirements, the use of fossil fuel, gaseous effluent, liquid effluent, and tailings solutions and solids, all listed in Table S–3, have been reviewed to determine the significance of the environmental impacts of a power reactor operating an additional 20 years. The nonradiological impacts attributable to the relicensing of an individual power reactor are found to be of small significance. License renewal of an individual plant is so indirectly connected to the operation of fuel cycle facilities that it is meaningless to address the mitigation of impacts identified above. This is a Category 1 issue.

Table S–3 does not take into account long-term onsite storage of LLW, mixed waste, and storage of spent fuel assemblies onsite for longer than 10 years, nor does it take into account impacts from mixed waste disposal. The environmental impacts of these aspects of onsite storage are also addressed in Chapter 6 of the final GEIS and the findings are included in the final rule in Table B–1 of appendix B to 10 CFR part 51.

Chapter 6 of the GEIS discusses the impacts of offsite disposal of LLW and mixed waste and concludes that impacts will be small. The conclusion that impacts will be small is based on the regulations and regulatory programs in place (e.g., 10 CFR part 61 for LLW and 40 CFR parts 261, 264, and 268 for hazardous waste), experience with existing sites, and the expectation that NRC, EPA, and the States will ensure that disposal will occur in compliance with the applicable regulations.

The Low-Level Radioactive Waste Policy Act of 1980 (LLRWPA) made the States responsible for the disposal of commercially generated LLW. At present, 9 compacts have been formed, representing 42 States. The Texas Compact (Texas, Maine, and Vermont) is pending before the U.S. Congress.

New LLW disposal facilities in the host States of California, North Carolina, and Texas are forecast to be operational between 1997 and 1998. Facilities in the host States of Connecticut, Illinois, Massachusetts, Nebraska, New Jersey, Pennsylvania, and New York are scheduled for operation between 1999 and 2002. Envirocare, in Utah, takes limited types of waste from certain generators.

There are uncertainties in the licensing process and in the length of time needed to resolve technical issues, but in NRC's view there are no unsolvable technical issues that will inevitably preclude successful development of new sites or other off-site disposal capacity for LLW by the time they will be needed. For example, in California, the proposed Ward Valley LLW disposal facility was unexpectedly delayed by the need to resolve technical issues raised by several scientists independent of the project after the license was issued. These issues were recently reviewed and largely resolved by an independent review group. In North Carolina, Texas, and Nebraska, the license application review period has been longer than is required by the LLRWPA, but progress continues to be made.

The State's LLW responsibilities include providing disposal capacity for mixed LLW. Mixed waste disposal facility developers face the same types of challenges as LLW site developers plus difficulties with dual regulation and small volumes. However, in NRC's view there are no technical reasons why offsite disposal capacity for all types of mixed waste should not become available when needed. NRC and EPA have developed guidance on the siting of mixed waste disposal facilities as well as a conceptual design for a mixed waste disposal facility. A disposal facility for certain types of mixed waste is operated by Envirocare in Utah. States have begun discussions with DOE about accepting commercial mixed waste for treatment and disposal at DOE facilities. Although these discussions have yet to result in DOE accepting commercial mixed waste at DOE facilities, it appears that progress is being made toward DOE's eventual acceptance of some portion of commercial mixed waste at its facilities.

While the NRC understands that there have been delays and that uncertainties exist such as those just discussed, the Commission concludes that there is reasonable assurance that sufficient LLW and mixed LLW disposal capacity will be made available when needed so that facilities can be decommissioned consistent with NRC decommissioning requirements. This conclusion, coupled with the expected small impacts from both storage and disposal justify classification of LLW and mixed waste disposal as Category 1 issues.

The GEIS addresses the matter of extended onsite storage of both LLW and mixed waste from refurbishment and operations for a renewal period of up to 20 years. Summary data are provided and radiological and nonradiological environmental impacts are addressed. The analysis considers:

(1) The volumes of LLW and mixed waste that may be generated from license renewal;

(2) Specific requirements under the existing regulatory framework;

(3) The effectiveness of the regulations in maintaining low average doses to members of the public and to workers; and

(4) Nonradiological impacts, including land use, fugitive dust, air quality, erosion, sedimentation, and disturbance of ecosystems.

In addition, under 10 CFR 50.59, licensees are allowed to make changes to their facilities as discussed in the final safety analysis report without NRC permission if the evaluation indicates that a change in the technical specifications is not required or that an unreviewed safety question does not exist. Licensees would have to ensure that any new LLW activities would not represent an unreviewed safety question for routine operations or for conditions that might arise from potential accidents. Both onsite and offsite impacts would have to be considered. If a LLW or mixed waste activity fails either of the two tests in 10 CFR 50.59, a license amendment is required. Subject to the two possible review requirements just noted, the Commission finds that continued onsite storage of both LLW and mixed waste resulting from license renewal will have small environmental impacts and will require no further review within the license renewal proceeding.

The GEIS addresses extended onsite storage of spent fuel during a renewal period of up to 20 years. The Commission has studied the safety and environmental effects of the temporary storage of spent fuel after cessation of reactor operation and has published a generic determination of no significant environmental impact (10 CFR 51.23). The environmental data on storing spent fuel onsite in a fuel pool for 10 years before shipping for offsite disposal have been assessed and reported in NUREG–0116, ''The Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle'' (October 1976), and published in the Commission's regulations (10 CFR 51.51). Environmental assessments (EA) for expanding the fuel pool storage capacity have been conducted for numerous plants. In each case, a finding of no significant environmental impact was reached.

Radioactive exposures, waste generation, and releases were evaluated and found to be small. The only nonradiological effluent from waste storage is additional heat from the plant that was found to have a negligible effect on the environment. Accidents were evaluated and were found to have insignificant effects on the environment. Dry cask storage at an independent spent fuel storage installation (ISFSI) is another technology used to store under a general license. The environmental impacts of allowing onsite dry cask storage under a general license were assessed in an EA and found to be insignificant. Further, the Commission has conducted EAs for seven specific licensed ISFSIs and has reached a finding of no significant environmental impact for each site. Each EA addressed the impacts of construction, use, and decommissioning. Potential impacts that were assessed include radiological impacts, land use, terrestrial resources, water use, aquatic resources, noise, air quality, socioeconomics, radiological impacts during construction and routine operation, and radiological impacts of off-normal events and accidents. Trends in onsite spent fuel storage capacity and the volume of spent fuel that will be generated during an additional 20 years of operation are considered in the GEIS. Spent fuel storage capacity requirements can be adequately met by ISFSIs without significant environmental impacts. The environmental impacts of onsite storage of spent fuel at all plants have been adequately assessed in the GEIS for the purposes of an environmental review and agency decision on renewal of an operating license; thus, no further review within the license renewal proceeding is required. This provision is relative to the license renewal decision and does not alter existing Commission licensing requirements specific to on-site storage of spent fuel.

The environmental impacts from the transportation of fuel and waste attributable to license renewal are found to be small when they are within the range of impacts of parameters identified in Table S–4. The estimated radiological effects are within regulatory standards. The nonradiological impacts are those from periodic shipments of fuel and waste by individual trucks or rail cars and thus would result in infrequent and localized minor contributions to traffic density. Programs designed to further reduce risk, which are already in place, provide for adequate mitigation. Recent, ongoing efforts by the Department of Energy to study the impacts of waste transportation in the context of the multi-purpose canister (see, 60 FR 45147, August 30, 1995) suggest that there may be unresolved issues regarding the magnitude of cumulative impacts from the use of a single rail line or truck route in the vicinity of the repository to carry all spent fuel from all plants. Accordingly, NRC declines to reach a Category 1 conclusion on this issue at this time. Table S–4 should continue to be the basis for case-by-case evaluation of transportation impacts of fuel and waste until such time as a detailed analysis of the environmental impacts of transportation to the proposed repository at Yucca Mountain becomes available.

9. Accidents

Concern. Several commenters expressed concerns regarding the appropriateness of the severe accident determination in the GEIS and with the treatment of severe accident mitigation design alternatives (SAMDAs) for license renewal. A group of commenters identified areas of concern that they believe justify severe accidents being classified as a Category 3 issue. The areas included seismic risks to nuclear power plants and site-specific evacuation risks. Several commenters questioned whether the analyses of the environmental impacts of accidents were adequate to make a Category 1 determination for the issue of severe accidents. The contention is that a bounding analysis would be established only if plant-specific analyses were performed for every plant, which was not the case. Instead, the GEIS analysis made use of a single generic source term for each of the two plant types.

Response. The Commission believes that its analysis of the impacts of severe accidents is appropriate. The GEIS provides an analysis of the consequences of severe accidents for each site in the country. The analysis adopts standard assumptions about each site for parameters such as evacuation speeds and distances traveled, and uses site-specific estimates for parameters such as population distribution and meteorological conditions. These latter two factors were used to evaluate the exposure indices for these analyses. The methods used result in predictions of risk that are adequate to illustrate the general magnitude and types of risks that may occur from reactor accidents. Regarding site-evacuation risk, the radiological risk to persons as they evacuate is taken into account within the individual plant risk assessments that form the basis for the GEIS. In addition, 10 CFR Part 50 requires that licensees maintain up-to-date emergency plans. This requirement will apply in the license renewal term as well as in the current licensing term.

As was done in the GEIS analysis, the use of generic source terms (one set for PWRs and another for BWRs) is consistent with the past practice that has been used and accepted by the NRC for individual plant Final Environmental Impact Statements (FEISs). The purpose of the source term discussion in the GEIS is to describe whether or not new information on source terms developed after the completion of the most recent FEISs indicates that the source terms used in the past under-predict environmental consequences. The NRC has concluded that analysis of the new source term information developed over the past 10 years indicates that the expected frequency and amounts of radioactive release under severe accident conditions are less than that predicted using the generic source terms. A summary of the evolution of this research is provided in NUREG–1150, ''Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants'' (December 1990), and its supporting documentation. Thus, the analyses performed for the GEIS represent adequate, plant-specific estimates of the impacts from severe accidents that would generally over-predict, rather than under-predict, environmental consequences. Therefore, the GEIS analysis of the impacts of severe accidents for license renewal is retained and is considered applicable to all plants.

Based on an evaluation of the comments, the Commission has reconsidered its previous conclusion in the draft GEIS concerning site-specific consideration of severe accident mitigation. The Commission has determined that a site-specific consideration of alternatives to mitigate severe accidents will be required at the time of license renewal unless a previous consideration of such alternatives regarding plant operation has been included in a final environmental impact statement or a related supplement. Because the third criterion required to make a Category 1 designation for an issue requires a generic consideration of mitigation, the issue of severe accidents must be reclassified as a Category 2 issue that requires a consideration of severe accident mitigation alternatives, provided this consideration has not already been completed. The Commission's reconsideration of the issue of severe accident mitigation for license renewal is based on the Commission's NEPA regulations that require a consideration of mitigation alternatives in its environmental impact statements (EISs) and supplements to EISs, as well as a previous court decision that required a review of severe mitigation alternatives (referred to as SAMDAs) at the operating license stage. See, *Limerick Ecology Action* v. *NRC*, 869 F.2d 719 (3d Cir. 1989).

Although the Commission has considered containment improvements for all plants pursuant to its Containment Performance Improvement (CPI) program, which identified potential containment improvements for site-specific consideration by licensees, and the Commission has additional ongoing regulatory programs whereby licensees search for individual plant vulnerabilities to severe accidents and consider cost-beneficial improvements, these programs have not yet been completed. Therefore, a conclusion that severe accident mitigation has been generically considered for license renewal is premature.

The Commission believes it unlikely that any site-specific consideration of severe accident mitigation alternatives for license renewal will identify major plant design changes or modifications that will prove to be cost-beneficial for reducing severe accident frequency or consequences. This Commission expectation regarding severe accident mitigation improvements is based on the analyses performed to date that are discussed below.

The Commission's CPI program examined each of the five U.S. containment types to determine potential failure modes, potential plant improvements, and the cost-effectivenesses of such improvements. As a result of this program, only a few containment improvements were found to be potentially beneficial and were either identified for further NRC research or for individual licensee evaluation.

In response to the *Limerick* decision, an NRC staff consideration of SAMDAs was specifically included in the Final Environmental Impact Statement for the Limerick 1 and 2 and Comanche Peak 1 and 2 operating license reviews, and in the Watts Bar Supplemental Final Environmental Statement for an operating license. The alternatives evaluated in these analyses included the items previously evaluated as part of the CPI Program, as well as improvements identified through other risk studies and analyses. No physical plant modifications were found to be cost-beneficial in any of these severe accident mitigation considerations. Only plant procedural changes were identified as being cost-beneficial. Furthermore, the Limerick analysis was for a high-population site. Because risk is generally proportional to the population around a plant, this analysis suggests that other sites are unlikely to identify significant plant modifications that are cost-beneficial.

Additionally, each licensee is performing an individual plant examination (IPE) to look for plant vulnerabilities to internally initiated events and a separate IPE for externally initiated events (IPEEE). The licensees were requested to report their results to the Commission. Seventy-eight IPE submittals were received and seventy-five IPEEE submittals will be received, covering all operating plants in the United States. These examinations consider potential improvements to reduce the frequency or consequences of severe accidents on a plant-specific basis and essentially constitute a broad search for severe accident mitigation alternatives. The NRC staff is conducting a process review of each plant-specific IPE submittal and IPEEE submittal. To date, all IPE submittals have received a preliminary review by the NRC with 46 out of 78 completed; for the IPEEE submittals, 24 of the 75 are under review. These IPEs have resulted in a number of plant procedural or programmatic improvements and some plant modifications that will further reduce the risk of severe accidents.

In conclusion, the GEIS analysis of severe accident consequences and risk is adequate, and additional plant-specific analysis of these impacts is not required. However, because the ongoing regulatory program related to severe accident mitigation (i.e., IPE and IPEEE) has not been completed for all plants and consideration of severe accident mitigation alternatives has not been included in an EIS or supplemental EIS related to plant operations for all plants, a site-specific consideration of severe accident mitigation alternatives is required at license renewal for those plants for which this consideration has not been performed. The Commission expects that if these reviews identify any changes as being cost beneficial, such changes generally would be procedural and programmatic fixes, with any hardware changes being only minor in nature and few in number. NRC staff considerations of severe accident mitigation alternatives have already been completed and included in an EIS or supplemental EIS for Limerick, Comanche Peak, and Watts Bar. Therefore, severe accident mitigation alternatives need not be reconsidered for these plants for license renewal.

Based on the fact that a generic consideration of mitigation is not performed in the GEIS, a Category 1 designation for severe accidents cannot be made. Therefore, the Commission has reclassified severe accidents as a Category 2 issue, requiring only that alternatives to mitigate severe accidents be considered for those plants that have not included such a consideration in a previous EIS or supplemental EIS. The Commission notes that upon completion of its IPE/IPEEE program, it may review the issue of severe accident mitigation for license renewal and consider, by separate rulemaking, reclassifying severe accidents as a Category 1 issue.

The Commission does not intend to prescribe by rule the scope of an acceptable consideration of severe accident mitigation alternatives for license renewal nor does it intend to mandate consideration of alternatives identical to those evaluated previously. In general, the Commission expects that significant efficiency can be gained by using site-specific IPE and IPEEE results in the consideration of severe accident mitigation alternatives. The IPEs and IPEEEs are essentially site-specific PRAs that identify probabilities of core damage (Level 1 PRA) and include assessments of containment performance under severe accident conditions that identify probabilities of fission product releases (Level 2). As discussed in Generic Letter 88–20, ''Individual Plant Examination for Severe Accident Vulnerabilities'' (November 23, 1988), one of the important goals of the IPE and IPEEE was to reduce the overall probabilities of core damage and fission product releases as necessary by modifying hardware and procedures to help prevent or mitigate severe accidents.

Although Level 3 PRAs have been used in SAMDA analyses to generate site-specific offsite dose estimates so that the cost-benefit of mitigation alternatives could be determined, the Commission does not believe that site-specific Level 3 PRAs are required to determine whether an alternative under consideration will provide sufficient benefit to justify its cost. Licensees can use other quantitative approaches for assigning site-specific risk significance to IPE results and judging whether a mitigation alternative provides a sufficient reduction in core damage frequency (CDF) or release frequency to warrant implementation. For example, a licensee could use information provided in the GEIS analysis (exposure indices, wind frequencies, and demographics) to translate the dominant contributors to CDF and the large release frequencies from the IPE/IPEEE results into dose estimates so that a cost-benefit determination can be performed. In some instances, a consideration of the magnitude of reduction in the site-specific CDF and release frequencies alone (i.e., no conversion to a dose estimate) may be sufficient to conclude that no significant reduction in off-site risk will be provided and, therefore, implementation of a mitigation alternative is not warranted. The Commission will review each severe accident mitigation consideration provided by a license renewal applicant on its merits and determine whether it constitutes a reasonable consideration of severe accident mitigation alternatives.

10. Decommissioning

Concern. Several commenters requested further clarification of the NRC's position regarding decommissioning requirements, especially whether the total impacts address returning the site to green field conditions.

Response. The decommissioning chapter of the GEIS analyzes the impact that an additional 20 years of plant operation would have on ultimate plant decommissioning; it neither serves as the generic analysis of the environmental impacts associated with decommissioning nor establishes decommissioning requirements. An analysis of the expected impacts from plant decommissioning was previously provided in NUREG–0586, ''Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities'' (August 1988). The analysis in the GEIS for license renewal examines the physical requirements and attendant effects of decommissioning after a 20-year license renewal compared with decommissioning at the end of 40 years of operation and finds little difference in effects.

With respect to returning a site to green field condition, the Commission defines decommissioning as the safe removal of a nuclear facility from service, the reduction of residual contamination to a level that permits release of the property for unrestricted use, and termination of the license. Therefore, the question of restoring the land to a green field condition, which would require additional demolition and site restoration beyond addressing residual contamination and radiological effects, is outside the current scope of the decommissioning requirements. Moreover, consistent with the Commission's conclusion that license renewal is not expected to affect future decommissioning, any requirement relative to returning a site to a green field and the attendant effects of such a requirement would also not be affected by an additional 20 years of operation. Therefore, the issue of returning a site to pre-construction conditions is beyond the scope of license renewal review.

Concern. Several commenters expressed concern that, because a residual radioactivity rule is still not in place, the LLW estimates should be reexamined.

Response. The NRC does have criteria in place for the release of reactor facilities to unrestricted access following decommissioning. These include the guidance in Regulatory Guide 1.86, ''Termination of Operating Licenses for Nuclear Reactors'' (which provides guidance for surface contamination), dose rate limits from gamma-emitting radionuclides included in plant technical specifications, and requirements for keeping residual contamination as low as reasonably achievable (ALARA) as included in 10 CFR part 20. These criteria were used in developing NUREG–0586, the final GEIS on decommissioning of nuclear facilities, which was published in August of 1988. One conclusion from the analysis conducted for NUREG–0586 was that waste volumes from decommissioning of reactors are not highly sensitive to the radiological criteria. A proposed rule dated August 22, 1994, would codify radiological criteria for unrestricted release of reactors and other nuclear facilities and for termination of a facility license following decommissioning. NUREG–1496, the draft GEIS for the proposed rule on radiological criteria, included analyses of a range of radiological release criteria and confirmed the earlier conclusions that waste volumes from decommissioning of reactors are not sensitive to the residual radiological criteria within the range likely to be selected. This range included residual dose levels comparable to the radiological criteria currently being used for reactor decommissioning. Based on the insensitivity of the waste volume from reactor decommissioning to the radiological criteria, the Commission continues to believe, as concluded in the decommissioning section of the GEIS, that the contribution to environmental impacts of decommissioning from license renewal are small. The Commission further concludes that these impacts are not expected to change significantly as a result of the ongoing rulemaking. Therefore, the determinations in the GEIS remain appropriate.

11. Need for Generating Capacity

Concern. In addition to the major procedural concern discussed earlier about the treatment of need for generating capacity, several commenters raised concerns about the power demand projections used in the GEIS. Some commenters noted that any determination of need quickly becomes dated and, therefore, the demand for and the source of electrical power at the time of license renewal cannot be accurately predicted at this time. Moreover, they believe that the NRC's analysis is not definitive enough to remain unchallenged for 40 years. Another commenter criticized the analysis because it focused only on energy requirements without making appropriate distinctions between energy and peak capacity requirements, plant availability, and capacity factors.

Response. The NRC has determined that a detailed consideration of the need for generating capacity is inappropriate in the context of consideration of the environmental impacts of license renewal. Thus, the NRC will limit its NEPA review of license renewal applications to the consideration of the environmental impacts of license renewal compared with those of other available generating sources. Hence, the concerns regarding demand projections used in the draft GEIS are no longer an issue and they have been removed from the GEIS.

12. Alternatives to License Renewal

Concern. In addition to the procedural concern discussed earlier about the treatment of alternative energy sources as a Category 1 issue, several commenters expressed concerns about the comparison and analysis of alternative energy sources, as well as the economic analysis approach used in the draft GEIS. Consistent with their arguments against the Category 1 designation of alternatives, the commenters questioned the approach adopted in the GEIS of comparing only single alternative energy sources to license renewal. They believe that the NRC's failure to consider a mix of alternatives ignores the potential for other alternative sources of power that are available to different regions of the nation, such as demand-side management, cogeneration, purchased power from Canada, biomass, natural gas, solar energy, and wind power. They also indicated that this approach neglects a utility's ability to serve its customers with a portfolio of supply that is based on load characteristics, cost, geography, and other considerations, and fails to consider the collective impact of the alternatives. Furthermore, the possible technological advances in renewable energy sources over the next 40 years are not addressed.

One commenter argued that designating the issue of alternative energy sources as Category 1 allows a license renewal applicant not to consider the additional requirement of economic threshold analysis. Relative to the economic analysis of the alternatives to license renewal, another commenter questioned the proposed requirement for the license renewal applicant to demonstrate that the ''replacement of equivalent generating capacity by a coal-fired plant has no demonstrated cost advantage over the individual nuclear power plant license renewal.''

According to the commenter, this requirement would force the applicant to perform an economic analysis of an alternative to license renewal. The commenter further argued that NEPA does not require an economic consideration.

Response. In response to these concerns, the final rule no longer requires a cost comparison of alternative energy sources relative to license renewal. Furthermore, the alternative energy sources discussed in the final GEIS include energy conservation and energy imports as well as the other sources discussed by the commenters. An analysis of the environmental impacts of alternative energy sources is included in the GEIS but is not codified in 10 CFR part 51.

The NRC believes that its consideration of alternatives in the GEIS is representative of the technologies available and the associated environmental impacts. With regard to consideration of a mix of alternative sources, the Commission recognizes that combinations of various alternatives may be used to replace power generation from license renewal.

13. License Renewal Scenario

Concern. Several commenters raised concerns related to the license renewal scenario evaluation methodology as implemented in the GEIS. The fundamental issues were the degree of conservatism built into the scenario and the appropriateness of an upper bound type approach in characterizing the refurbishment activities (and associated costs) in light of NEPA requirements to determine reasonable estimates of the environmental impacts of Federal actions.

Regarding the concerns that the refurbishment schedules and scenarios developed for the GEIS were too conservative, several commenters indicated that many of the activities slated for completion during the extended refurbishment before license renewal would actually be completed by many facilities during the course of the current licensing term. The effect of having only one major outage instead of leveling work over three or four outages could lead to an over-estimate of the refurbishment activities and costs that any particular plant would expect to see.

Response. In response to this concern, the NRC has revised the GEIS to include two license renewal program scenarios. The first scenario refers to a ''typical'' license renewal program and is intended to be representative of the type of programs that many plants seeking license renewal might implement. The second scenario retains the original objective of establishing an upper bound of the impacts likely to be generated at any particular plant. The typical scenario is useful for estimating impacts at plants that have been well maintained and have already undertaken most major refurbishment activities necessary for operation beyond the current licensing term. The conservative scenario estimates continue to be useful for estimating the maximum impacts likely to result from license renewal.

The revised approach of providing two separate license renewal scenarios also alleviates the concern about the use of a bounding scenario for license renewal activities. The NRC acknowledges that some applicants for license renewal may not be required to perform certain major refurbishment or replacement activities and, therefore, may have fewer or shorter outages. However, the two scenarios described in the GEIS are neither unrealistic nor overconservative in representing the range of activities that could be expected for license renewal and the possible schedule for performing these activities.

14. Environmental Justice

On February 11, 1994, the President issued Executive Order (E.O.) 12898, ''Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations'' (59 FR 7629, February 16, 1994). This order requires each Federal agency to make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low income populations. The Commission will endeavor to carry out the measures set forth in the executive order by integrating environmental justice into NRC's compliance with the National Environmental Policy of 1969 (NEPA), as amended. E.O. 12898 was issued after publication of the proposed rule and the receipt of comments on the proposed rule. As a result, no comments were received regarding environmental justice reviews for license renewal. Therefore, a brief discussion of this issue relative to license renewal is warranted.

As called for in Section 1–102 of E.O. 12898, the EPA established a Federal interagency working group to, among other things, ''* * * provide guidance to Federal agencies or criteria for identifying disproportionately high and adverse human health or environmental effects on minority populations and low-income populations * * *.'' The CEQ was assigned to provide this guidance to enable agencies to better comply with E.O. 12898. Until the CEQ guidance is received, the Commission intends to consider environmental justice in its evaluations of individual license renewal applications. Greater emphasis will be placed on discussing impacts on minority and low-income populations when preparing NEPA documents such as EISs, supplemental EISs, and, where appropriate, EAs. Commission requirements regarding environmental justice reviews will be reevaluated and may be revised after receipt of the CEQ guidance.

IV. Discussion of Regulatory Requirements

A. General Requirements

In this final rule, the regulatory requirements for performing a NEPA review for a license renewal application are similar to the NEPA review requirements for other major plant licensing actions. Consistent with the current NEPA practice for major plant licensing actions, this amendment to 10 CFR Part 51 requires the applicant to submit an environmental report that analyzes the environmental impacts associated with the proposed action, considers alternatives to the proposed action, and evaluates any alternatives for reducing adverse environmental effects. Additionally, the amendment requires the NRC staff to prepare a supplemental environmental impact statement for the proposed action, issue the statement in draft for public comment, and issue a final statement after considering public comments on the draft.

The amendment deviates from NRC's current NEPA review practice in some areas. First, the amendment codifies certain environmental impacts associated with license renewal that were analyzed in NUREG–1437, ''Generic Environmental Impact Statement for License Renewal at Nuclear Plants'' (xxxx 1996). Accordingly, absent new and significant information, the analyses for certain impacts codified by this rulemaking need only be incorporated by reference in an applicant's environmental report for license renewal and in the Commission's (including NRC staff, adjudicatory officers, and the Commission itself) draft and final SEIS and other environmental documents developed for the proceeding. Secondly, the amendment reflects the Commission's decision to limit its NEPA review for license renewal to a consideration of the environmental effects of the proposed action and alternatives to the proposed action. Finally, the amendment contains the decision standard that the Commission will use in determining the acceptability of the environmental impacts of individual license renewals.

The Commission and the applicant will consider severe accident mitigation alternatives to reduce or mitigate environmental impacts for any plant for which severe accident mitigation alternatives have not been previously considered in an environmental impact statement or related supplement or in an environmental assessment. The Commission has concluded that, for license renewal, the issues of need for power and utility economics should be reserved for State and utility officials to decide. Accordingly, the NRC will not conduct an analysis of these issues in the context of license renewal or perform traditional cost-benefit balancing in license renewal NEPA reviews. Finally, in a departure from the approach presented in the proposed rule, this final rule does not codify any conclusions regarding the subject of alternatives. Consideration of and decisions regarding alternatives will occur at the site-specific stage. The discussion below addresses the specific regulatory requirements of this amendment and any conforming changes to 10 CFR part 51 to implement the Commission's decision to eliminate cost-benefit balancing from license renewal NEPA reviews.

B. The Environmental Report

1. Environmental Impacts of License Renewal

Through this final rule, the NRC has amended 10 CFR 51.53 to require an applicant for license renewal to submit an environmental report with its application. This environmental report must contain an analysis of the environmental impacts of renewing a license, the environmental impacts of alternatives, and mitigation alternatives. In preparing the analysis of environmental impacts contained in the environmental report, the applicant should refer to the data provided in appendix B to 10 CFR part 51, which has been added to NRC's regulations as part of this rulemaking. The applicant is not required to provide an analysis in the environmental report of those issues identified as Category 1 issues in Table B–1 in Appendix B. For those issues identified as Category 2 in Table B–1, the applicant must provide a specified additional analysis beyond that contained in Table B–1. In this final rule, 10 CFR 51.53(c)(3)(ii) specifies the subject areas of the analysis that must be addressed for the Category 2 issues.

Pursuant to 10 CFR 51.45(c), 10 CFR 51.53(c)(2) requires the applicant to consider possible actions to mitigate the adverse impacts associated with the proposed action. This consideration is limited to designated Category 2 matters. Pursuant to 10 CFR 51.45(d), the environmental report must include a discussion of the status of compliance with applicable Federal, State, and local environmental standards. Also, 10 CFR 51.53(c)(2) specifically excludes from consideration in the environmental report the issues of need for power, the economic costs and benefits of the proposed action, economic costs and benefits of alternatives to the proposed action, or other issues not related to environmental effects of the proposed action and associated alternatives. In addition, the requirements in 10 CFR 51.45 are consistent with the exclusion of economic issues in 10 CFR 51.53(c)(2).

2. Consideration of Alternatives

Pursuant to 10 CFR 51.45(c), 10 CFR 51.53(c)(2) requires the applicant to consider the environmental impacts of alternatives to license renewal in the environmental report. The treatment of alternatives in the environmental report should be limited to the environmental impacts of such alternatives.

The amended regulations do not require a discussion of the economic costs and benefits of these alternatives in the environmental report for the operating license renewal stage except as necessary to determine whether an alternative should be included in the range of alternatives considered or whether certain mitigative actions are appropriate. The analysis should demonstrate consideration of a reasonable set of alternatives to license renewal. In preparing the alternatives analysis, the applicant may consider information regarding alternatives in NUREG–1437, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants'' (xxxx 1996).

The Commission has developed a new decision standard to be applied in environmental impact statements for license renewal as discussed in Section IV.C.2. The amended regulations for license renewal do not require applicants to apply this decision standard to the information generated in their environmental report (although the applicant is not prohibited from doing so if it desires). However, the NRC staff will use the information contained in the environmental report in preparing the environmental impact statement upon which the Commission will base its final decision.

3. Consideration of Mitigation Alternatives

Consistent with the NRC's current NEPA practice, an applicant must include a consideration of alternatives to mitigate adverse environmental impacts in its environmental report. However, for license renewal, the Commission has generically considered mitigation for environmental issues associated with renewal and has concluded that no additional site-specific consideration of mitigation is necessary for many issues. The Commission's consideration of mitigation for each issue included identification of current activities that adequately mitigate impacts and evaluation of other mitigation techniques that might or might not be warranted, depending on such factors as the size of the impact and the cost of the technique. The Commission has considered mitigation for all impacts designated as Category 1 in Table B–1. Therefore, a license renewal applicant need not address mitigation for issues so designated.

C. Supplemental Environmental Impact Statement

This amendment also requires that the Commission prepare a supplemental environmental impact statement (SEIS), consistent with 10 CFR 51.20(b)(2). This statement will serve as the Commission's independent analysis of the environmental impacts of license renewal as well as a comparison of these impacts to the environmental impacts of alternatives. This document will also present the preliminary recommendation by the NRC staff regarding the proposed action. Consistent with the revisions to 10 CFR 51.45 and 51.53 discussed above in regard to the applicant's environmental report, this rulemaking revises portions of 10 CFR 51.71 and 51.95 to reflect the Commission's approach to addressing the environmental impacts of license renewal.

The issues of need for power, the economic costs and benefits of the proposed action, and economic costs and benefits of alternatives to the proposed action are specifically excluded from consideration in the supplemental environmental impact statement for license renewal by 10 CFR 51.95(c), except as these costs and benefits are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation. The supplemental environmental impact statement does not need to discuss issues other than environmental effects of the proposed action and associated alternatives. This rule amends the requirements in 10 CFR 51.71 (d) and (e) so that they are consistent with the exclusion of economic issues in 10 CFR 51.95(c). Additionally, 10 CFR 51.95 has been amended to allow information from previous NRC site-specific environmental reviews, as well as NRC final generic environmental impact statements, to be referenced in supplemental environmental impact statements.

1. Public Scoping and Public Comments on the SEIS

Consistent with NRC's current NEPA practice, the Commission will hold a public meeting in order to inform the local public of the proposed action and receive comments. In addition, the SEIS will be issued in draft for public comment in accordance with 10 CFR 51.91 and 51.93. In both the public scoping process and the public comment process, the Commission will accept comments on all previously analyzed issues and information codified in Table B–1 of appendix B to 10 CFR part 51 and will determine whether these comments provide any information that is new and significant compared with that previously considered in the GEIS. If the comments are determined to provide new and significant information bearing on the previous analysis in the GEIS, these comments will be considered and appropriately factored into the Commission's analysis in the SEIS. Public comments on the site-specific additional information provided by the applicant regarding Category 2 issues will be considered in the SEIS.

2. Commission's Analysis and Preliminary Recommendation

The Commission's draft SEIS will include its analysis of the environmental impacts of the proposed license renewal action and the environmental impacts of the alternatives to the proposed action. With the exception of offsite radiological impacts for collective effects and the disposal of spent fuel and high level waste, the Commission will integrate the codified environmental impacts of license renewal as provided in Table B–1 of appendix B to 10 CFR part 51 (supplemented by the underlying analyses in the GEIS), the appropriate site-specific analyses of Category 2 issues, and any new issues identified during the scoping and public comment process. The results of this integration process will be utilized to arrive at a conclusion regarding the sum of the environmental impacts associated with license renewal. These impacts will then be compared, quantitatively or qualitatively as appropriate, with the environmental impacts of the considered alternatives. The analysis of alternatives in the SEIS will be limited to the environmental impacts of these alternatives and will be prepared in accordance with 10 CFR 51.71 and subpart A of appendix A to 10 CFR part 51. The analysis of impacts of alternatives provided in the GEIS may be referenced in the SEIS as appropriate. The alternatives discussed in the GEIS include a reasonable range of different methods for power generation. The analysis in the draft SEIS will consider mitigation actions for designated Category 2 matters and will consider the status of compliance with Federal, State, and local environmental requirements as required by 10 CFR 51.71(d). Consistent with 10 CFR 51.71(e), the draft supplemental environmental impact statement must contain a preliminary recommendation regarding license renewal based on consideration of the information on the environmental impacts of license renewal and of alternatives contained in the SEIS. In order to reach its recommendation, the NRC staff must determine whether the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable. This decision standard is contained in 10 CFR 51.95(c)(4).

3. Final Supplemental Environmental Impact Statement

The Commission will issue a final supplemental environmental impact statement for a license renewal application in accordance with 10 CFR 51.91 and 51.93 after considering the public comments related to new issues identified from the scoping and public comment process, Category 2 issues, and any new and significant information regarding previously analyzed and codified Category 1 issues. Pursuant to 10 CFR 51.102 and 51.103, the Commission will provide a record of its decision regarding the environmental impacts of the proposed action. In making a final decision, the Commission must determine whether the adverse environmental impacts of license renewal (when compared with the environmental impacts of other energy generating alternatives) are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable.

D. NEPA Review for Activities Outside NRC License Renewal Approval Scope

The Commission wishes to clarify that any activity that requires NRC approval and is not specifically required for NRC's action regarding management of the effects of aging on certain passive long-lived structures and components in the period of extended operation must be subject to a separate NEPA review. The actions subject to NRC approval for license renewal are limited to continued operation consistent with the plant design and operating conditions for the current operating license and to the performance of specific activities and programs necessary to manage the effects of aging on the passive, long-lived structures and components identified in accordance with 10 CFR part 54. Accordingly, the GEIS does not serve as the NEPA review for other activities or programs outside the scope of NRC's part 54 license renewal review. The separate NEPA review must be prepared regardless of whether the action is necessary as a consequence of receiving a renewed license, even if the activity were specifically addressed in the GEIS. For example, the environmental impacts of spent fuel pool expansion are addressed in the GEIS in the context of the environmental consequences of approving a renewed operating license, rather than in the context of a specific application to expand spent fuel pool capacity, which would require a separate NEPA review.

These separate NEPA reviews may reference and otherwise use applicable environmental information contained in the GEIS. For example, an EA prepared for a separate spent fuel pool expansion request may use the information in the GEIS to support a finding of no significant impact.

V. Availability of Documents

The principal documents supporting this supplementary information are as follows:

(1) NUREG–1437, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants'' (May 1996).

(2) NUREG–1529, ''Public Comments on the Proposed 10 CFR part 51 Rule for Renewal of Nuclear Power Plant Operating Licenses and Supporting Documents; Review of Concerns and NRC Staff Response'' (May 1996).

(3) NUREG–1440, ''Regulatory Analysis of Amendments to Regulations Concerning the Environmental Review

for Renewal of Nuclear Power Plant Operating Licenses'' (May 1996).

Copies of all documents cited in the supplementary information are available for inspection and for copying for a fee in the NRC Public Document Room, 2120 L Street NW. (Lower Level), Washington, DC. In addition, copies of NRC final documents cited here may be purchased from the Superintendent of Documents, U.S. Government Printing Office, PO Box 37082, Washington, DC 20013–7082. Copies are also available for purchase from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

VI. Submittal of Comments in an Electronic Format

Commenters are encouraged to submit, in addition to the original paper copy, a copy of their letter in an electronic format on IBM PC DOS-compatible 3.5- or 5.25-inch, double-sided, double-density (DS/DD) diskettes. Data files should be provided in Wordperfect 5.1 or later version of Wordperfect. ASCII code is also acceptable or, if formatted text is required, data files should be provided in IBM Revisable-Form Text Document Content Architecture (RFT/DCA) format.

VII. Finding of No Significant Environmental Impact: Availability

The NRC has determined that this final rule is the type of action described as a categorical exclusion in 10 CFR 51.22(c)(3). Therefore, neither an environmental impact statement nor an environmental assessment has been prepared for this regulation. This action is procedural in nature and pertains only to the type of environmental information to be reviewed.

VIII. Paperwork Reduction Act Statement

This final rule amends information collection requirements that are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 *et seq.*). These requirements were approved by the Office of Management and Budget, approval number 3150–0021.

The public reporting burden for this collection of information is estimated to average 4,200 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to the Information and Records Management Branch (T–6F33), U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001, or by Internet electronic mail at BJS1@nrc.gov; and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB–10202 (3150–0021), Office of Management and Budget, Washington, DC 20503.

Public Protection Notification

The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

IX. Regulatory Analysis

The Commission has prepared a regulatory analysis for this final rule. The analysis examines the costs and benefits of the alternatives considered by the Commission. The two alternatives considered were:

(A) Retaining the existing 10 CFR part 51 review process for license renewal, which requires that all reviews be on a plant-specific basis; and

(B) Amending 10 CFR part 51 to allow a portion of the environmental review to be conducted on a generic basis.

The conclusions of the regulatory analysis show substantial cost savings of alternative (B) over alternative (A). The analysis, NUREG–1440, is available for inspection in the NRC Public Document Room, 2120 L Street NW. (Lower Level), Washington, DC. Copies of the analysis are available as described in Section V.

X. Regulatory Flexibility Act Certification

As required by the Regulatory Flexibility Act of 1980, 5 U.S.C. 605(b), the Commission certifies that this final rule will not have a significant impact on a substantial number of small entities. The final rule states the application procedures and environmental information to be submitted by nuclear power plant licensees to facilitate NRC's obligations under NEPA. Nuclear power plant licensees do not fall within the definition of small businesses as defined in Section 3 of the Small Business Act, 15 U.S.C. 632, or the Commission's Size Standards, April 11, 1995 (60 FR 18344).

XI. Small Business Regulatory Enforcement Fairness Act

In accordance with the Small Business Regulatory Enforcement Fairness Act of 1996, the NRC has determined that this action is not a major rule and has verified this determination with the Office of Information and Regulatory Affairs of OMB.

XII. Backfit Analysis

The NRC has determined that these amendments do not involve any provisions which would impose backfits as defined in 10 CFR 50.109(a)(1); therefore, a backfit analysis need not be prepared.

List of Subjects in 10 CFR Part 51

Administrative practice and procedure, Environmental impact statement, Nuclear materials, Nuclear power plants and reactors, Reporting and recordkeeping requirements.

For the reasons set out in the preamble and under the authority of the Atomic Energy Act of 1954, as amended; the Energy Reorganization Act of 1974, as amended; the National Environmental Policy Act of 1969, as amended; and 5 U.S.C. 552 and 553, the NRC is adopting the following amendments to 10 CFR part 51.

PART 51—ENVIRONMENTAL PROTECTION REGULATIONS FOR DOMESTIC LICENSING AND RELATED REGULATORY FUNCTIONS

1. The authority citation for part 51 continues to read as follows:

Authority: Sec. 161, 68 Stat. 948, as amended, Sec. 1701, 106 Stat. 2951, 2952, 2953 (42 U.S.C. 2201, 2297f); secs. 201, as amended, 202, 88 Stat. 1242, as amended, 1244 (42 U.S.C. 5841, 5842).

Subpart A also issued under National Environmental Policy Act of 1969, secs. 102, 104, 105, 83 Stat. 853–854, as amended (42 U.S.C. 4332, 4334, 4335); and Pub. L. 95–604, Title II, 92 Stat. 3033–3041. Sections 51.20, 51.30, 51.60, 51.61, 51.80, and 51.97 also issued under secs. 135, 141, Pub. L. 97–425, 96 Stat. 2232, 2241, and sec. 148, Pub. L. 100–203, 101 Stat. 1330–223 (42 U.S.C. 10155, 10161, 10168). Section 51.22 also issued under sec. 274, 73 Stat. 688, as amended by 92 Stat. 3036–3038 (42 U.S.C. 2021) and under Nuclear Waste Policy Act of 1982, sec. 121, 96 Stat. 2228 (42 U.S.C. 10141). Sections 51.43, 51.67, and 51.109 also issued under Nuclear Waste Policy Act of 1982, sec. 114(f), 96 Stat. 2216, as amended (42 U.S.C. 10134(f)).

2. Section 51.45 is amended by revising paragraph (c) to read as follows:

§ 51.45 Environmental report.

* * * * *

(c) *Analysis.* The environmental report shall include an analysis that considers and balances the environmental effects of the proposed action, the environmental impacts of alternatives to the proposed action, and alternatives available for reducing or avoiding adverse environmental effects. Except for environmental reports prepared at the license renewal stage pursuant to § 51.53(c), the analysis in the environmental report should also include consideration of the economic, technical, and other benefits and costs of the proposed action and of alternatives. Environmental reports prepared at the license renewal stage pursuant to § 51.53(c) need not discuss the economic or technical benefits and costs of either the proposed action or alternatives except insofar as such benefits and costs are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation. In addition, environmental reports prepared pursuant to § 51.53(c) need not discuss other issues not related to the environmental effects of the proposed action and alternatives. The analyses for environmental reports shall, to the fullest extent practicable, quantify the various factors considered. To the extent that there are important qualitative considerations or factors that cannot be quantified, those considerations or factors shall be discussed in qualitative terms. The environmental report should contain sufficient data to aid the Commission in its development of an independent analysis.

* * * * *

3. Section 51.53 is revised to read as follows:

§ 51.53 Postconstruction environmental reports.

(a) *General.* Any environmental report prepared under the provisions of this section may incorporate by reference any information contained in a prior environmental report or supplement thereto that relates to the production or utilization facility or any information contained in a final environmental document previously prepared by the NRC staff that relates to the production or utilization facility. Documents that may be referenced include, but are not limited to, the final environmental impact statement; supplements to the final environmental impact statement, including supplements prepared at the license renewal stage; NRC staff-prepared final generic environmental impact statements; and environmental assessments and records of decisions prepared in connection with the construction permit, the operating license, and any license amendment for that facility.

(b) *Operating license stage.* Each applicant for a license to operate a production or utilization facility covered by § 51.20 shall submit with its application the number of copies specified in § 51.55 of a separate document entitled ''Supplement to Applicant's Environmental Report—Operating License Stage,'' which will update ''Applicant's Environmental Report—Construction Permit Stage.'' Unless otherwise required by the Commission, the applicant for an operating license for a nuclear power reactor shall submit this report only in connection with the first licensing action authorizing full-power operation. In this report, the applicant shall discuss the same matters described in §§ 51.45, 51.51, and 51.52, but only to the extent that they differ from those discussed or reflect new information in addition to that discussed in the final environmental impact statement prepared by the Commission in connection with the construction permit. No discussion of need for power, or of alternative energy sources, or of alternative sites for the facility, or of any aspect of the storage of spent fuel for the facility within the scope of the generic determination in § 51.23(a) and in accordance with § 51.23(b) is required in this report.

(c) *Operating license renewal stage.* (1) Each applicant for renewal of a license to operate a nuclear power plant under part 54 of this chapter shall submit with its application the number of copies specified in § 51.55 of a separate document entitled ''Applicant's Environmental Report—Operating License Renewal Stage.''

(2) The report must contain a description of the proposed action, including the applicant's plans to modify the facility or its administrative control procedures as described in accordance with § 54.21 of this chapter. This report must describe in detail the modifications directly affecting the environment or affecting plant effluents that affect the environment. In addition, the applicant shall discuss in this report the environmental impacts of alternatives and any other matters described in § 51.45. The report is not required to include discussion of need for power or the economic costs and economic benefits of the proposed action or of alternatives to the proposed action except insofar as such costs and benefits are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation. The environmental report need not discuss other issues not related to the environmental effects of the proposed action and the alternatives. In addition, the environmental report need not discuss any aspect of the storage of spent fuel for the facility within the scope of the generic determination in § 51.23(a) and in accordance with § 51.23(b).

(3) For those applicants seeking an initial renewal license and holding either an operating license or construction permit as of June 30, 1995, the environmental report shall include the information required in paragraph (c)(2) of this section subject to the following conditions and considerations:

(i) The environmental report for the operating license renewal stage is not required to contain analyses of the environmental impacts of the license renewal issues identified as Category 1 issues in appendix B to subpart A of this part.

(ii) The environmental report must contain analyses of the environmental impacts of the proposed action, including the impacts of refurbishment activities, if any, associated with license renewal and the impacts of operation during the renewal term, for those issues identified as Category 2 issues in appendix B to subpart A of this part. The required analyses are as follows:

(A) If the applicant's plant utilizes cooling towers or cooling ponds and withdraws make-up water from a river whose annual flow rate is less than 3.15×10^{12} ft^3/year (9×10^{10} m^3/year), an assessment of the impact of the proposed action on the flow of the river and related impacts on instream and riparian ecological communities must be provided. The applicant shall also provide an assessment of the impacts of the withdrawal of water from the river on alluvial aquifers during low flow.

(B) If the applicant's plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of current Clean Water Act 316(b) determinations and, if necessary, a 316(a) variance in accordance with 40 CFR part 125, or equivalent State permits and supporting documentation. If the applicant can not provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from heat shock and impingement and entrainment.

(C) If the applicant's plant uses Ranney wells or pumps more than 100 gallons of ground water per minute, an assessment of the impact of the proposed action on ground-water use must be provided.

(D) If the applicant's plant is located at an inland site and utilizes cooling ponds, an assessment of the impact of the proposed action on groundwater quality must be provided.

(E) All license renewal applicants shall assess the impact of refurbishment and other license-renewal-related construction activities on important plant and animal habitats. Additionally, the applicant shall assess the impact of the proposed action on threatened or endangered species in accordance with the Endangered Species Act.

(F) If the applicant's plant is located in or near a nonattainment or maintenance area, an assessment of vehicle exhaust emissions anticipated at the time of peak refurbishment workforce must be provided in accordance with the Clean Air Act as amended.

(G) If the applicant's plant uses a cooling pond, lake, or canal or discharges into a river having an annual average flow rate of less than 3.15×10^{12} ft^3/year (9×10^{10} m^3/year), an assessment of the impact of the proposed action on public health from thermophilic organisms in the affected water must be provided.

(H) If the applicant's transmission lines that were constructed for the specific purpose of connecting the plant to the transmission system do not meet the recommendations of the National Electric Safety Code for preventing electric shock from induced currents, an assessment of the impact of the proposed action on the potential shock hazard from the transmission lines must be provided.

(I) An assessment of the impact of the proposed action on housing availability, land-use, and public schools (impacts from refurbishment activities only) within the vicinity of the plant must be provided. Additionally, the applicant shall provide an assessment of the impact of population increases attributable to the proposed project on the public water supply.

(J) All applicants shall assess the impact of the proposed project on local transportation during periods of license renewal refurbishment activities.

(K) All applicants shall assess whether any historic or archaeological properties will be affected by the proposed project.

(L) If the staff has not previously considered severe accident mitigation alternatives for the applicant's plant in an environmental impact statement or related supplement or in an environmental assessment, a consideration of alternatives to mitigate severe accidents must be provided.

(M) The environmental effects of transportation of fuel and waste shall be reviewed in accordance with § 51.52.

(iii) The report must contain a consideration of alternatives for reducing adverse impacts, as required by § 51.45(c), for all Category 2 license renewal issues in Appendix B to Subpart A of this part. No such consideration is required for Category 1 issues in Appendix B to Subpart A of this part.

(iv) The environmental report must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

(d) *Postoperating license stage.* Each applicant for a license amendment authorizing the decommissioning of a production or utilization facility covered by § 51.20 and each applicant for a license or license amendment to store spent fuel at a nuclear power plant after expiration of the operating license for the nuclear power plant shall submit with its application the number of copies specified in § 51.55 of a separate document entitled ''Supplement to Applicant's Environmental Report—Post Operating License Stage.'' This supplement will update ''Supplement to Applicant's Environmental Report—Operating License Stage'' and ''Applicant's Environmental Report—Operating License Renewal Stage,'' as appropriate, to reflect any new information or significant environmental change associated with the applicant's proposed decommissioning activities or with the applicant's proposed activities with respect to the planned storage of spent fuel. Unless otherwise required by the Commission, in accordance with the generic determination in § 51.23(a) and the provisions in § 51.23(b), the applicant shall address only the environmental impact of spent fuel storage for the term of the license.

4. In § 51.55, paragraph (a) is revised to read as follows:

§ 51.55 Environmental report—number of copies; distribution.

(a) Each applicant for a license to construct and operate a production or utilization facility covered by paragraphs (b)(1), (b)(2), (b)(3), or (b)(4) of § 51.20, each applicant for renewal of an operating license for a nuclear power plant, each applicant for a license amendment authorizing the decommissioning of a production or utilization facility covered by § 51.20, and each applicant for a license or license amendment to store spent fuel at a nuclear power plant after expiration of the operating license for the nuclear power plant shall submit to the Director of the Office of Nuclear Reactor Regulation or the Director of the Office of Nuclear Material Safety and Safeguards, as appropriate, 41 copies of an environmental report or any supplement to an environmental report. The applicant shall retain an additional 109 copies of the environmental report or any supplement to the environmental report for distribution to parties and Boards in the NRC proceedings; Federal, State, and local officials; and any affected Indian tribes, in accordance with written instructions issued by the Director of the Office of Nuclear Reactor Regulation or the Director of the Office Nuclear Material Safety and Safeguards, as appropriate.

* * * * *

5. In § 51.71, paragraphs (d) and (e) are revised to read as follows:

§ 51.71 Draft environmental impact statement—contents.

* * * * *

(d) *Analysis.* The draft environmental impact statement will include a preliminary analysis that considers and weighs the environmental effects of the proposed action; the environmental impacts of alternatives to the proposed action; and alternatives available for reducing or avoiding adverse environmental effects. Except for supplemental environmental impact statements for the operating license renewal stage prepared pursuant to § 51.95(c), draft environmental impact statements should also include consideration of the economic, technical, and other benefits and costs of the proposed action and alternatives and indicate what other interests and considerations of Federal policy, including factors not related to environmental quality if applicable, are relevant to the consideration of environmental effects of the proposed action identified pursuant to paragraph (a) of this section. Supplemental environmental impact statements prepared at the license renewal stage pursuant to § 51.95(c) need not discuss the economic or technical benefits and costs of either the proposed action or alternatives except insofar as such benefits and costs are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation. In addition, the supplemental environmental impact statement prepared at the license renewal stage need not discuss other issues not related to the environmental effects of the proposed action and associated alternatives. The draft supplemental environmental impact statement for license renewal prepared pursuant to § 51.95(c) will rely on conclusions as amplified by the supporting information in the GEIS for issues designated as Category 1 in appendix B to subpart A of this part. The draft supplemental environmental impact statement must contain an analysis of those issues identified as Category 2 in appendix B to subpart A of this part that are open for the proposed action. The analysis for all draft environmental impact statements will, to the fullest extent practicable, quantify the various factors considered. To the extent that there are important qualitative considerations or factors that cannot be quantified, these considerations or factors will be discussed in qualitative terms. Due consideration will be given to compliance with environmental quality standards and requirements that have been imposed by Federal, State, regional, and local agencies having responsibility for environmental protection, including applicable zoning and land-use regulations and water pollution limitations or requirements promulgated or imposed pursuant to the Federal Water Pollution Control Act. The environmental impact of the proposed action will be considered in the analysis with respect to matters covered by such standards and requirements irrespective of whether a certification or license from the appropriate authority has been obtained.[3] While satisfaction of Commission standards and criteria pertaining to radiological effects will be necessary to meet the licensing requirements of the Atomic Energy Act, the analysis will, for the purposes of NEPA, consider the radiological effects of the proposed action and alternatives.

(e) *Preliminary recommendation.* The draft environmental impact statement normally will include a preliminary recommendation by the NRC staff respecting the proposed action. This preliminary recommendation will be based on the information and analysis described in paragraphs (a) through (d) of this section and §§ 51.75, 51.76, 51.80, 51.85, and 51.95, as appropriate, and will be reached after considering the environmental effects of the proposed action and reasonable alternatives,[4] and, except for supplemental environmental impact statements for the operating license renewal stage prepared pursuant to § 51.95(c), after weighing the costs and benefits of the proposed action. In lieu of a recommendation, the NRC staff may indicate in the draft statement that two or more alternatives remain under consideration.

[3] Compliance with the environmental quality standards and requirements of the Federal Water Pollution Control Act (imposed by EPA or designated permitting states) is not a substitute for and does not negate the requirement for NRC to weigh all environmental effects of the proposed action, including the degradation, if any, of water quality, and to consider alternatives to the proposed action that are available for reducing adverse effects. Where an environmental assessment of aquatic impact from plant discharges is available from the permitting authority, the NRC will consider the assessment in its determination of the magnitude of environmental impacts for striking an overall cost-benefit balance at the construction permit and operating license stages, and in its determination of whether the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable at the license renewal stage. When no such assessment of aquatic impacts is available from the permitting authority, NRC will establish on its own or in conjunction with the permitting authority and other agencies having relevant expertise the magnitude of potential impacts for striking an overall cost-benefit balance for the facility at the construction permit and operating license stages, and in its determination of whether the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable at the license renewal stage.

[4] The consideration of reasonable alternatives to a proposed action involving nuclear power reactors (e.g., alternative energy sources) is intended to assist the NRC in meeting its NEPA obligations and does not preclude any State authority from making separate determinations with respect to these alternatives and in no way preempts, displaces, or affects the authority of States or other Federal agencies to address these issues.

§ 51.75 [Amended]

6. In Section 51.75, redesignate footnote 4 as footnote 5.

7. Section 51.95 is revised to read as follows:

§ 51.95 Postconstruction environmental impact statements.

(a) *General.* Any supplement to a final environmental impact statement or any environmental assessment prepared under the provisions of this section may incorporate by reference any information contained in a final environmental document previously prepared by the NRC staff that relates to the same production or utilization facility. Documents that may be referenced include, but are not limited to, the final environmental impact statement; supplements to the final environmental impact statement, including supplements prepared at the operating license stage; NRC staff-prepared final generic environmental impact statements; environmental assessments and records of decisions prepared in connection with the construction permit, the operating license, and any license amendment for that facility. A supplement to a final environmental impact statement will include a request for comments as provided in § 51.73.

(b) *Initial operating license stage.* In connection with the issuance of an operating license for a production or utilization facility, the NRC staff will prepare a supplement to the final environmental impact statement on the construction permit for that facility, which will update the prior environmental review. The supplement will only cover matters that differ from the final environmental impact statement or that reflect significant new information concerning matters discussed in the final environmental impact statement. Unless otherwise determined by the Commission, a supplement on the operation of a nuclear power plant will not include a discussion of need for power, or of alternative energy sources, or of alternative sites, or of any aspect of the storage of spent fuel for the nuclear power plant within the scope of the generic determination in § 51.23(a) and in accordance with § 51.23(b), and will only be prepared in connection with the first licensing action authorizing full-power operation.

(c) *Operating license renewal stage.* In connection with the renewal of an operating license for a nuclear power plant under part 54 of this chapter, the Commission shall prepare a supplement to the Commission's NUREG–1437, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants'' (xxxx 1996).

(1) The supplemental environmental impact statement for the operating license renewal stage shall address those issues as required by § 51.71. In addition, the NRC staff must comply with 40 CFR 1506.6(b)(3) in conducting the additional scoping process as required by § 51.71(a).

(2) The supplemental environmental impact statement for license renewal is not required to include discussion of need for power or the economic costs and economic benefits of the proposed action or of alternatives to the proposed action except insofar as such benefits and costs are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation. In addition, the supplemental environmental impact statement prepared at the license renewal stage need not discuss other issues not related to the environmental effects of the proposed action and the alternatives, or any aspect of the storage of spent fuel for the facility within the scope of the generic determination in § 51.23(a) and in accordance with § 51.23(b). The analysis of alternatives in the supplemental environmental impact statement should be limited to the environmental impacts of such alternatives and should otherwise be prepared in accordance with § 51.71 and appendix A to subpart A of this part.

(3) The supplemental environmental impact statement shall be issued as a final impact statement in accordance with §§ 51.91 and 51.93 after considering any significant new information relevant to the proposed

action contained in the supplement or incorporated by reference.

(4) The supplemental environmental impact statement must contain the NRC staff's recommendation regarding the environmental acceptability of the license renewal action. In order to make its recommendation and final conclusion on the proposed action, the NRC staff, adjudicatory officers, and Commission shall integrate the conclusions, as amplified by the supporting information in the generic environmental impact statement for issues designated Category 1 (with the exception of offsite radiological impacts for collective effects and the disposal of spent fuel and high level waste) or resolved Category 2, information developed for those open Category 2 issues applicable to the plant in accordance with § 51.53(c)(3)(ii), and any significant new information. Given this information, the NRC staff, adjudicatory officers, and Commission shall determine whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable.

(d) *Postoperating license stage.* In connection with an amendment to an operating license authorizing the decommissioning of a production or utilization facility covered by § 51.20 or with the issuance, amendment, or renewal of a license to store spent fuel at a nuclear power plant after expiration of the operating license for the nuclear power plant, the NRC staff will prepare a supplemental environmental impact statement for the postoperating license stage or an environmental assessment, as appropriate, which will update the prior environmental review. Unless otherwise required by the Commission, in accordance with the generic determination in § 51.23(a) and the provisions of § 51.23(b), a supplemental environmental impact statement for the postoperating license stage or an environmental assessment, as appropriate, will address the environmental impacts of spent fuel storage only for the term of the license, license amendment, or license renewal applied for.

8. In § 51.103, paragraph (a)(3) is revised and paragraph (a)(5) is added to read as follows:

§ 51.103 Record of decision—General.

(a) * * *

(3) Discuss preferences among alternatives based on relevant factors, including economic and technical considerations where appropriate, the NRC's statutory mission, and any essential considerations of national policy, which were balanced by the Commission in making the decision and state how these considerations entered into the decision.

* * * * *

(5) In making a final decision on a license renewal action pursuant to part 54 of this chapter, the Commission shall determine whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable.

* * * * *

9. Paragraph 4 of appendix A to subpart A of 10 CFR part 51 is revised as follows:

Appendix A to Subpart A—Format for Presentation of Material in Environmental Impact Statements

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4. *Purpose of and need for action.* The statement will briefly describe and specify the need for the proposed action. The alternative of no action will be discussed. In the case of nuclear power plant construction or siting, consideration will be given to the potential impact of conservation measures in determining the demand for power and consequent need for additional generating capacity.

* * * * *

10. A new appendix B is added to subpart A of 10 CFR part 51 to read as follows:

Appendix B to Subpart A—Environmental Effect of Renewing the Operating License of a Nuclear Power Plant

The Commission has assessed the environmental impacts associated with granting a renewed operating license for a nuclear power plant to a licensee who holds either an operating license or construction permit as of June 30, 1995. Table B–1 summarizes the Commission's findings on the scope and magnitude of environmental impacts of renewing the operating license for a nuclear power plant as required by section 102(2) of the National Environmental Policy Act of 1969, as amended. Table B–1, subject to an evaluation of those issues identified in Category 2 as requiring further analysis and possible significant new information, represents the analysis of the environmental impacts associated with renewal of any operating license and is to be used in accordance with § 51.95(c). On a 10-year cycle, the Commission intends to review the material in this appendix and update it if necessary. A scoping notice must be published in the Federal Register indicating the results of the NRC's review and inviting public comments and proposals for other areas that should be updated.

TABLE B–1.—SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS [1]

Issue	Category [2]	Findings [3]
Surface Water Quality, Hydrology, and Use (for all plants)		
Impacts of refurbishment on surface water quality.	1	SMALL. Impacts are expected to be negligible during refurbishment because best management practices are expected to be employed to control soil erosion and spills.
Impacts of refurbishment on surface water use.	1	SMALL. Water use during refurbishment will not increase appreciably or will be reduced during plant outage.
Altered current patterns at intake and discharge structures.	1	SMALL. Altered current patterns have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Altered salinity gradients	1	SMALL. Salinity gradients have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Altered thermal stratification of lakes.	1	SMALL. Generally, lake stratification has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Temperature effects on sediment transport capacity.	1	SMALL. These effects have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Scouring caused by discharged cooling water.	1	SMALL. Scouring has not been found to be a problem at most operating nuclear power plants and has caused only localized effects at a few plants. It is not expected to be a problem during the license renewal term.
Eutrophication	1	SMALL. Eutrophication has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.

TABLE B–1.—SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS [1]—Continued

Issue	Category [2]	Findings [3]
Discharge of chlorine or other biocides.	1	SMALL. Effects are not a concern among regulatory and resource agencies, and are not expected to be a problem during the license renewal term.
Discharge of sanitary wastes and minor chemical spills.	1	SMALL. Effects are readily controlled through NPDES permit and periodic modifications, if needed, and are not expected to be a problem during the license renewal term.
Discharge of other metals in waste water.	1	SMALL. These discharges have not been found to be a problem at operating nuclear power plants with cooling-tower-based heat dissipation systems and have been satisfactorily mitigated at other plants. They are not expected to be a problem during the license renewal term.
Water use conflicts (plants with once-through cooling systems).	1	SMALL. These conflicts have not been found to be a problem at operating nuclear power plants with once-through heat dissipation systems.
Water use conflicts (plants with cooling ponds or cooling towers using make-up water from a small river with low flow).	2	SMALL OR MODERATE. The issue has been a concern at nuclear power plants with cooling ponds and at plants with cooling towers. Impacts on instream and riparian communities near these plants could be of moderate significance in some situations. See § 51.53(c)(3)(ii)(A).
Aquatic Ecology (for all plants)		
Refurbishment	1	SMALL. During plant shutdown and refurbishment there will be negligible effects on aquatic biota because of a reduction of entrainment and impingement of organisms or a reduced release of chemicals.
Accumulation of contaminants in sediments or biota.	1	SMALL. Accumulation of contaminants has been a concern at a few nuclear power plants but has been satisfactorily mitigated by replacing copper alloy condenser tubes with those of another metal. It is not expected to be a problem during the license renewal term.
Entrainment of phytoplankton and zooplankton.	1	SMALL. Entrainment of phytoplankton and zooplankton has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Cold shock	1	SMALL. Cold shock has been satisfactorily mitigated at operating nuclear plants with once-through cooling systems, has not endangered fish populations or been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds, and is not expected to be a problem during the license renewal term.
Thermal plume barrier to migrating fish.	1	SMALL. Thermal plumes have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Distribution of aquatic organisms	1	SMALL. Thermal discharge may have localized effects but is not expected to affect the larger geographical distribution of aquatic organisms.
Premature emergence of aquatic insects.	1	SMALL. Premature emergence has been found to be a localized effect at some operating nuclear power plants but has not been a problem and is not expected to be a problem during the license renewal term.
Gas supersaturation (gas bubble disease).	1	SMALL. Gas supersaturation was a concern at a small number of operating nuclear power plants with once-through cooling systems but has been satisfactorily mitigated. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.
Low dissolved oxygen in the discharge.	1	SMALL. Low dissolved oxygen has been a concern at one nuclear power plant with a once-through cooling system but has been effectively mitigated. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses.	1	SMALL. These types of losses have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Stimulation of nuisance organisms (e.g., shipworms).	1	SMALL. Stimulation of nuisance organisms has been satisfactorily mitigated at the single nuclear power plant with a once-through cooling system where previously it was a problem. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.
Aquatic Ecology (for plants with once-through and cooling pond heat dissipation systems)		
Entrainment of fish and shellfish in early life stages.	2	SMALL, MODERATE, OR LARGE. The impacts of entrainment are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. Further, ongoing efforts in the vicinity of these plants to restore fish populations may increase the numbers of fish susceptible to intake effects during the license renewal period, such that entrainment studies conducted in support of the original license may no longer be valid. See § 51.53(c)(3)(ii)(B).
Impingement of fish and shellfish	2	SMALL, MODERATE, OR LARGE. The impacts of impingement are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. See § 51.53(c)(3)(ii)(B).
Heat shock	2	SMALL, MODERATE, OR LARGE. Because of continuing concerns about heat shock and the possible need to modify thermal discharges in response to changing environmental conditions, the impacts may be of moderate or large significance at some plants. See § 51.53(c)(3)(ii)(B).

TABLE B–1.—SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS [1]—Continued

Issue	Category [2]	Findings [3]
Aquatic Ecology (for plants with cooling-tower-based heat dissipation systems)		
Entrainment of fish and shellfish in early life stages.	1	SMALL. Entrainment of fish has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.
Impingement of fish and shellfish	1	SMALL. The impingement has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.
Heat shock	1	SMALL. Heat shock has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.
Ground-water Use and Quality		
Impacts of refurbishment on ground-water use and quality.	1	SMALL. Extensive dewatering during the original construction on some sites will not be repeated during refurbishment on any sites. Any plant wastes produced during refurbishment will be handled in the same manner as in current operating practices and are not expected to be a problem during the license renewal term.
Ground-water use conflicts (potable and service water; plants that use <100 gpm).	1	SMALL. Plants using less than 100 gpm are not expected to cause any ground-water use conflicts.
Ground-water use conflicts (potable and service water, and dewatering; plants that use >100 gpm).	2	SMALL, MODERATE, OR LARGE. Plants that use more than 100 gpm may cause ground-water use conflicts with nearby ground-water users. See § 51.53(c)(3)(ii)(C).
Ground-water use conflicts (plants using cooling towers withdrawing make-up water from a small river).	2	SMALL, MODERATE, OR LARGE. Water use conflicts may result from surface water withdrawals from small water bodies during low flow conditions which may affect aquifer recharge, especially if other ground-water or upstream surface water users come on line before the time of license renewal. See § 51.53(c)(3)(ii)(A).
Terrestrial Resources		
Refurbishment impacts	2	SMALL, MODERATE, OR LARGE. Refurbishment impacts are insignificant if no loss of important plant and animal habitat occurs. However, it cannot be known whether important plant and animal communities may be affected until the specific proposal is presented with the license renewal application. See § 51.53(c)(3)(ii)(E).
Cooling tower impacts on crops and ornamental vegetation.	1	SMALL. Impacts from salt drift, icing, fogging, or increased humidity associated with cooling tower operation have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Cooling tower impacts on native plants.	1	SMALL. Impacts from salt drift, icing, fogging, or increased humidity associated with cooling tower operation have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Bird collisions with cooling towers.	1	SMALL. These collisions have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Cooling pond impacts on terrestrial resources.	1	SMALL. Impacts of cooling ponds on terrestrial ecological resources are considered to be of small significance at all sites.
Power line right-of-way management (cutting and herbicide application).	1	SMALL. The impacts of right-of-way maintenance on wildlife are expected to be of small significance at all sites.
Bird collision with power lines	1	SMALL. Impacts are expected to be of small significance at all sites.
Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock).	1	SMALL. No significant impacts of electromagnetic fields on terrestrial flora and fauna have been identified. Such effects are not expected to be a problem during the license renewal term.
Floodplains and wetland on power line right of way.	1	SMALL. Periodic vegetation control is necessary in forested wetlands underneath power lines and can be achieved with minimal damage to the wetland. No significant impact is expected at any nuclear power plant during the license renewal term.
Threatened or Endangered Species (for all plants)		
Threatened or endangered species.	2	SMALL, MODERATE, OR LARGE. Generally, plant refurbishment and continued operation are not expected to adversely affect threatened or endangered species. However, consultation with appropriate agencies would be needed at the time of license renewal to determine whether threatened or endangered species are present and whether they would be adversely affected. See § 51.53(c)(3)(ii)(E).

TABLE B–1.—SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS [1]—Continued

Issue	Category [2]	Findings [3]
Air Quality		
Air quality during refurbishment (nonattainment and maintenance areas).	2	SMALL, MODERATE, OR LARGE. Air quality impacts from plant refurbishment associated with license renewal are expected to be small. However, vehicle exhaust emissions could be cause for concern at locations in or near nonattainment or maintenance areas. The significance of the potential impact cannot be determined without considering the compliance status of each site and the numbers of workers expected to be employed during the outage. See § 51.53(c)(3)(ii)(F).
Air quality effects of transmission lines.	1	SMALL. Production of ozone and oxides of nitrogen is insignificant and does not contribute measurably to ambient levels of these gases.
Land Use		
Onsite land use	1	SMALL. Projected onsite land use changes required during refurbishment and the renewal period would be a small fraction of any nuclear power plant site and would involve land that is controlled by the applicant.
Power line right of way	1	SMALL. Ongoing use of power line right of ways would continue with no change in restrictions. The effects of these restrictions are of small significance.
Human Health		
Radiation exposures to the public during refurbishment.	1	SMALL. During refurbishment, the gaseous effluents would result in doses that are similar to those from current operation. Applicable regulatory dose limits to the public are not expected to be exceeded.
Occupational radiation exposures during refurbishment.	1	SMALL. Occupational doses from refurbishment are expected to be within the range of annual average collective doses experienced for pressurized-water reactors and boiling-water reactors. Occupational mortality risk from all causes including radiation is in the mid-range for industrial settings.
Microbiological organisms (occupational health).	1	SMALL. Occupational health impacts are expected to be controlled by continued application of accepted industrial hygiene practices to minimize worker exposures.
Microbiological organisms (public health) (plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river).	2	SMALL, MODERATE, OR LARGE. These organisms are not expected to be a problem at most operating plants except possibly at plants using cooling ponds, lakes, or canals that discharge to small rivers. Without site-specific data, it is not possible to predict the effects generically. See § 51.53(c)(3)(ii)(G).
Noise	1	SMALL. Noise has not been found to be a problem at operating plants and is not expected to be a problem at any plant during the license renewal term.
Electromagnetic fields, acute effects (electric shock).	2	SMALL, MODERATE, OR LARGE. Electrical shock resulting from direct access to energized conductors or from induced charges in metallic structures have not been found to be a problem at most operating plants and generally are not expected to be a problem during the license renewal term. However, site-specific review is required to determine the significance of the electric shock potential at the site. See § 51.53(c)(3)(ii)(H).
Electromagnetic fields, chronic effects [5].	NA [4]	UNCERTAIN. Biological and physical studies of 60–Hz electromagnetic fields have not found consistent evidence linking harmful effects with field exposures. However, because the state of the science is currently inadequate, no generic conclusion on human health impacts is possible.[5]
Radiation exposures to public (license renewal term).	1	SMALL. Radiation doses to the public will continue at current levels associated with normal operations.
Occupational radiation exposures (license renewal term).	1	SMALL. Projected maximum occupational doses during the license renewal term are within the range of doses experienced during normal operations and normal maintenance outages, and would be well below regulatory limits.
Socioeconomics		
Housing impacts	2	SMALL, MODERATE, OR LARGE. Housing impacts are expected to be of small significance at plants located in a medium or high population area and not in an area where growth control measures that limit housing development are in effect. Moderate or large housing impacts of the workforce associated with refurbishment may be associated with plants located in sparsely populated areas or in areas with growth control measures that limit housing development. See § 51.53(c)(3)(ii)(I).
Public services: public safety, social services, and tourism and recreation.	1	SMALL. Impacts to public safety, social services, and tourism and recreation are expected to be of small significance at all sites.
Public services: public utilities	2	SMALL OR MODERATE. An increased problem with water shortages at some sites may lead to impacts of moderate significance on public water supply availability. See § 51.53(c)(3)(ii)(I).
Public services, education (refurbishment).	2	SMALL, MODERATE, OR LARGE. Most sites would experience impacts of small significance but larger impacts are possible depending on site- and project-specific factors. See § 51.53(c)(3)(ii)(I).

TABLE B–1.—SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS [1]—Continued

Issue	Category [2]	Findings [3]
Public services, education (license renewal term).	1	SMALL. Only impacts of small significance are expected.
Offsite land use (refurbishment)	2	SMALL OR MODERATE. Impacts may be of moderate significance at plants in low population areas. See § 51.53(c)(3)(ii)(I).
Offsite land use (license renewal term).	2	SMALL, MODERATE, OR LARGE. Significant changes in land use may be associated with population and tax revenue changes resulting from license renewal. See § 51.53(c)(3)(ii)(I).
Public services, Transportation	2	SMALL, MODERATE, OR LARGE. Transportation impacts are generally expected to be of small significance. However, the increase in traffic associated with the additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites. See § 51.53(c)(3)(ii)(J).
Historic and archaeological resources.	2	SMALL, MODERATE, OR LARGE. Generally, plant refurbishment and continued operation are expected to have no more than small adverse impacts on historic and archaeological resources. However, the National Historic Preservation Act requires the Federal agency to consult with the State Historic Preservation Officer to determine whether there are properties present that require protection. See § 51.53(c)(3)(ii)(K).
Aesthetic impacts (refurbishment).	1	SMALL. No significant impacts are expected during refurbishment.
Aesthetic impacts (license renewal term).	1	SMALL. No significant impacts are expected during the license renewal term.
Aesthetic impacts of transmission lines (license renewal term).	1	SMALL. No significant impacts are expected during the license renewal term.
Postulated Accidents		
Design basis accidents	1	SMALL. The NRC staff has concluded that the environmental impacts of design basis accidents are of small significance for all plants.
Severe accidents	2	SMALL. The probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives. See § 51.53(c)(3)(ii)(L).
Uranium Fuel Cycle and Waste Management		
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high level waste).	1	SMALL. Off-site impacts of the uranium fuel cycle have been considered by the Commission in Table S–3 of this part. Based on information in the GEIS, impacts on individuals from radioactive gaseous and liquid releases including radon-222 and technetium-99 are small.
Offsite radiological impacts (collective effects).	1	The 100 year environmental dose commitment to the U.S. population from the fuel cycle, high level waste and spent fuel disposal is calculated to be about 14,800 person rem, or 12 cancer fatalities, for each additional 20 year power reactor operating term. Much of this, especially the contribution of radon releases from mines and tailing piles, consists of tiny doses summed over large populations. This same dose calculation can theoretically be extended to include many tiny doses over additional thousands of years as well as doses outside the U.S. The result of such a calculation would be thousands of cancer fatalities from the fuel cycle, but this result assumes that even tiny doses have some statistical adverse health effect which will not ever be mitigated (for example, no cancer cure in the next thousand years), and that these does projection over thousands of years are meaningful. However these assumptions are questionable. In particular, science cannot rule out the possibility that there will be no cancer fatalities from these tiny doses. For perspective, the doses are very small fractions of regulatory limits, and even smaller fractions of natural background exposure to the same populations. Nevertheless, despite all the uncertainty, some judgement as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the collective effects of the fuel cycle, this issue is considered Category 1.

TABLE B–1.—SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS [1]—Continued

Issue	Category [2]	Findings [3]
Offsite radiological impacts (spent fuel and high level waste disposal).	1	For the high level waste and spent fuel disposal component of the fuel cycle, there are no current regulatory limits for offsite releases of radionuclides for the current candidate repository site. However, if we assume that limits are developed along the lines of the 1995 National Academy of Sciences (NAS) report, ''Technical Bases for Yucca Mountain Standards,'' and that in accordance with the Commission's Waste Confidence Decision, 10 CFR 51.23, a repository can and likely will be developed at some site which will comply with such limits, peak doses to virtually all individuals will be 100 millirem per year or less. However, while the Commission has reasonable confidence that these assumptions will prove correct, there is considerable uncertainty since the limits are yet to be developed, no repository application has been completed or reviewed, and uncertainty is inherent in the models used to evaluate possible pathways to the human environment. The NAS report indicated that 100 millirem per year should be considered as a starting point for limits for individual doses, but notes that some measure of consensus exists among national and international bodies that the limits should be a fraction of the 100 millirem per year. The lifetime individual risk from 100 millirem annual dose limit is about 310^{-3}. Estimating cumulative doses to populations over thousands of years is more problematic. The likelihood and consequences of events that could seriously compromise the integrity of a deep geologic repository were evaluated by the Department of Energy in the ''Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste,'' October 1980. The evaluation estimated the 70-year whole-body dose commitment to the maximum individual and to the regional population resulting from several modes of breaching a reference repository in the year of closure, after 1,000 years, after 100,000 years, and after 100,000,000 years. Subsequently, the NRC and other federal agencies have expended considerable effort to develop models for the design and for the licensing of a high level waste repository, especially for the candidate repository at Yucca Mountain. More meaningful estimates of doses to population may be possible in the future as more is understood about the performance of the proposed Yucca Mountain repository. Such estimates would involve very great uncertainty, especially with respect to cumulative population doses over thousands of years. The standard proposed by the NAS is a limit on maximum individual dose. The relationship of potential new regulatory requirements, based on the NAS report, and cumulative population impacts has not been determined, although the report articulates the view that protection of individuals will adequately protect the population for a repository at Yucca Mountain. However, EPA's generic repository standards in 40 CFR part 191 generally provide an indication of the order of magnitude of cumulative risk to population that could result from the licensing of a Yucca Mountain repository, assuming the ultimate standards will be within the range of standards now under consideration. The standards in 40 CFR part 191 protect the population by imposing ''containment requirements'' that limit the cumulative amount of radioactive material released over 10,000 years. The cumulative release limits are based on EPA's population impact goal of 1,000 premature cancer deaths world-wide for a 100,000 metric tonne (MTHM) repository. Nevertheless, despite all the uncertainty, some judgement as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent fuel and high level waste disposal, this issue is considered Category 1.
Nonradiological impacts of the uranium fuel cycle.	1	SMALL. The nonradiological impacts of the uranium fuel cycle resulting from the renewal of an operating license for any plant are found to be small.
Low-level waste storage and disposal.	1	SMALL. The comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts to the environment will remain small during the term of a renewed license. The maximum additional on-site land that may be required for low-level waste storage during the term of a renewed license and associated impacts will be small. Nonradiological impacts on air and water will be negligible. The radiological and nonradiological environmental impacts of long-term disposal of low-level waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient low-level waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.
Mixed waste storage and disposal.	1	SMALL. The comprehensive regulatory controls and the facilities and procedures that are in place ensure proper handling and storage, as well as negligible doses and exposure to toxic materials for the public and the environment at all plants. License renewal will not increase the small, continuing risk to human health and the environment posed by mixed waste at all plants. The radiological and nonradiological environmental impacts of long-term disposal of mixed waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient mixed waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

TABLE B–1.—SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS [1]—Continued

Issue	Category [2]	Findings [3]
On-site spent fuel	1	SMALL. The expected increase in the volume of spent fuel from an additional 20 years of operation can be safely accommodated on site with small environmental effects through dry or pool storage at all plants if a permanent repository or monitored retrievable storage is not available.
Nonradiological waste	1	SMALL. No changes to generating systems are anticipated for license renewal. Facilities and procedures are in place to ensure continued proper handling and disposal at all plants.
Transportation	2	Table S–4 of this part contains an assessment of impact parameters to be used in evaluating transportation effects in each case. See § 51.53(c)(3)(ii)(M).
Decommissioning		
Radiation doses	1	SMALL. Doses to the public will be well below applicable regulatory standards regardless of which decommissioning method is used. Occupational doses would increase no more than 1 man-rem caused by buildup of long-lived radionuclides during the license renewal term.
Waste management	1	SMALL. Decommissioning at the end of a 20-year license renewal period would generate no more solid wastes than at the end of the current license term. No increase in the quantities of Class C or greater than Class C wastes would be expected.
Air quality	1	SMALL. Air quality impacts of decommissioning are expected to be negligible either at the end of the current operating term or at the end of the license renewal term.
Water quality	1	SMALL. The potential for significant water quality impacts from erosion or spills is no greater whether decommissioning occurs after a 20-year license renewal period or after the original 40-year operation period, and measures are readily available to avoid such impacts.
Ecological resources	1	SMALL. Decommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts.
Socioeconomic impacts	1	SMALL. Decommissioning would have some short-term socioeconomic impacts. The impacts would not be increased by delaying decommissioning until the end of a 20-year relicense period, but they might be decreased by population and economic growth.
Environmental Justice		
Environmental justice [6]	NA [4]	NONE. The need for and the content of an analysis of environmental justice will be addressed in plant-specific reviews. [6]

[1] Data supporting this table are contained in NUREG–1437, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants'' (xxxx 1996).

[2] The numerical entries in this column are based on the following category definitions:

Category 1: For the issue, the analysis reported in the Generic Environmental Impact Statement has shown:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic;

(2) A single significance level (i.e., small, moderate, or large) has been assigned to the impacts (except for collective off site radiological impacts from the fuel cycle and from high level waste and spent fuel disposal); and

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

The generic analysis of the issue may be adopted in each plant-specific review.

Category 2: For the issue, the analysis reported in the Generic Environmental Impact Statement has shown that one or more of the criteria of Category 1 can not be met, and therefore additional plant-specific review is required.

[3] The impact findings in this column are based on the definitions of three significance levels. Unless the significance level is identified as beneficial, the impact is adverse, or in the case of ''small,'' may be negligible. The definitions of significance follow:

SMALL—For the issue, environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered small as the term is used in this table.

MODERATE—For the issue, environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

LARGE—For the issue, environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

For issues where probability is a key consideration (i.e. accident consequences), probability was a factor in determining significance.

[4] NA (not applicable). The categorization and impact finding definitions do not apply to these issues.

[5] Scientific evidence about a chronic biological effect on humans from exposure to transmission line electric and magnetic fields is inconclusive. If the Commission finds that a consensus has been reached by appropriate Federal health agencies that there are adverse health effects, the Commission will require applicants to submit plant-specific reviews of these health effects. Until such time, applicants for license renewal are not required to submit information on this issue.

[6] Environmental Justice was not addressed in NUREG–1437, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants,'' because guidance for implementing Executive Order 12898 issued on February 11, 1994, was not available prior to completion of NUREG–1437. This issue will be addressed in individual license renewal reviews.

NUREG-1437
Supplement 5

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 5

Regarding Turkey Point Units 3 and 4

Final Report

Manuscript Completed: January 2002
Date Published: January 2002

Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

vicinity of the Turkey Point site, there is a large Hispanic minority population and a smaller Black minority population. In Figure 4-1, there is a large shaded area that covers most of the Florida Everglades in Miami-Dade County. This area, generally lying to the west of the Florida Turnpike, the cities of Homestead, Florida City, and Miami and extending to the boundaries of Broward County on the north and Collier and Monroe counties on the west, is one large census block group. Although the minority population characteristics are similar to other census block groups that are much smaller geographically, this large census block group has a very low population density. It could mistakenly give the impression that there is a large minority population when there is not because of the presence of the Everglades.

Most of the low-income population census block groups (Figure 4-2) in Miami-Dade County are concentrated in central Miami and just outside and to the south of the Miami metropolitan city limits. In Broward County, most of the census block groups are in Fort Lauderdale and along the Miami-Dade/Broward county line.

With the locations of minority and low-income populations identified, the staff proceeded to evaluate whether any of the environmental impacts of the proposed action could affect these populations in a disproportionately high and adverse manner. Based on staff guidance (NRC 1999b), air, land, and water resources within about 80 km (50 mi) of the Turkey Point site were examined. Within that area, a few potential environmental impacts could affect human populations; all of these were considered SMALL for the general population.

The pathways through which the environmental impacts associated with Turkey Point Units 3 and 4 license renewal can affect human populations are discussed in each associated section. The staff evaluated whether minority and low-income populations could be disproportionately affected by these impacts. The staff found no unusual resource dependencies or practices, such as subsistence agriculture, hunting, or fishing, through which the populations could be disproportionately high and adversely affected. In addition, the staff did not identify any location-dependent disproportionately high and adverse impacts affecting these minority and low-income populations. The staff concludes that offsite impacts from Turkey Point Units 3 and 4 to minority and low-income populations would be SMALL, and no special mitigation actions are warranted.

4.5 Groundwater Use and Quality

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to Turkey Point Units 3 and 4 groundwater use and quality are listed in Table 4-8. FPL stated in its ER that it is not aware of any new and significant information associated with the renewal of the Turkey Point Units 3 and 4 OLs (FPL 2000a). The staff has not identified any significant new information during its independent review of the FPL ER (FPL 2000a), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to this issue beyond those discussed in the GEIS. For this

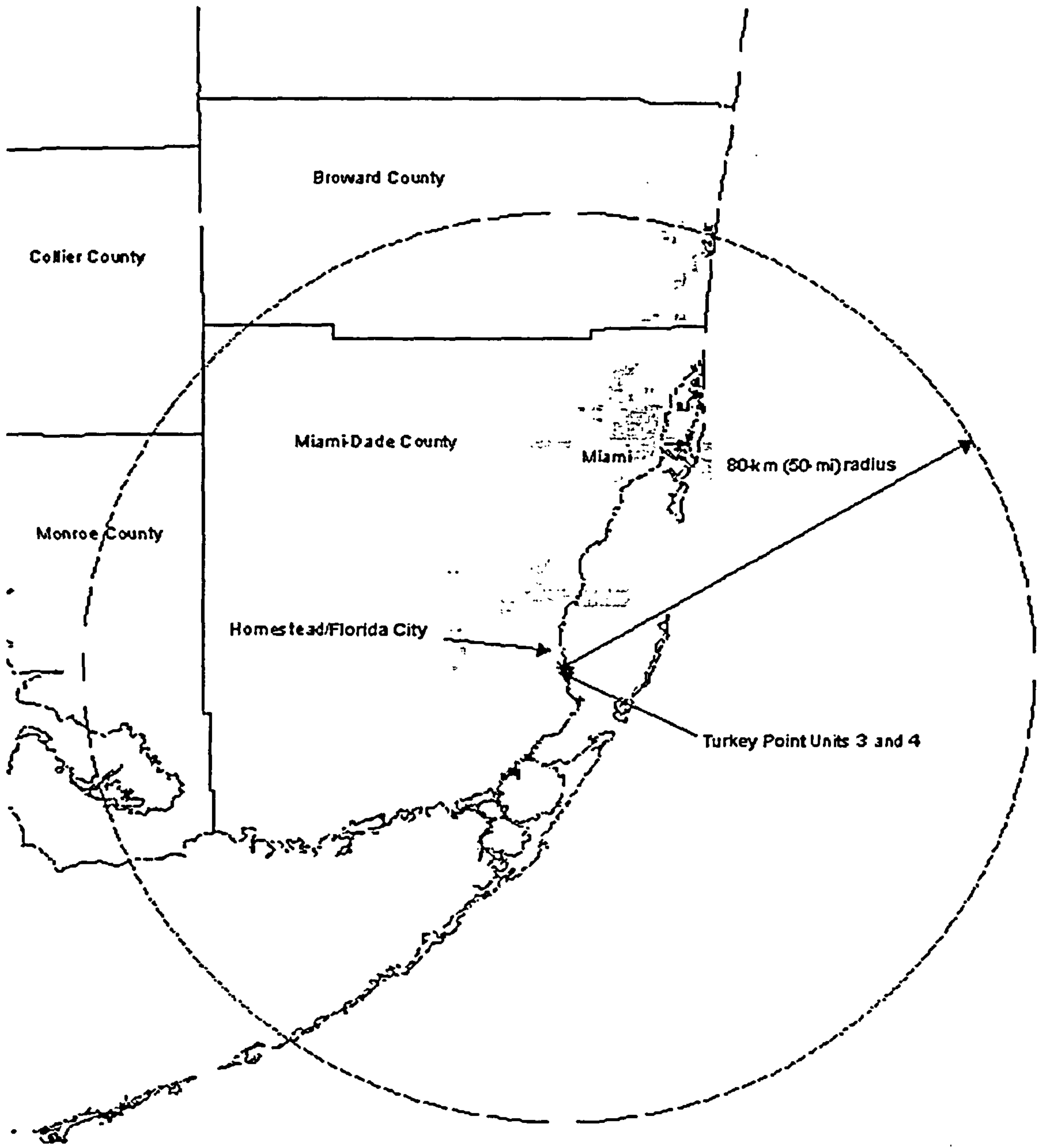

Figure 4-2. Geographic Distribution of Low-Income Populations (shown in shaded areas) Within 80 km (50 mi) of the Turkey Point Site Based on Census Block Group Data[(a)]

(a) Note: Some of the census block groups extend into open water.

Table 4-8. Category 1 Issues Applicable to Groundwater Use and Quality During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
GROUNDWATER USE AND QUALITY	
Groundwater use conflicts (potable and service water; plants that use <100 gpm).	4.8.1.1
Groundwater quality degradation (saltwater intrusion)	4.8.2.1
Groundwater quality degradation (cooling ponds in salt marshes)	4.8.3

issue, the GEIS concluded that the impacts are SMALL, and plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, 10 CFR 51, follows.

- Groundwater use conflicts (potable and service water; plants that use <100 gpm). Based on information in the GEIS, the Commission found that

  "Plants using less than 100 gpm are not expected to cause any ground-water use conflicts."

  As discussed in Section 2.2.2, Turkey Point Units 3 and 4 groundwater use is less than 0.068 m^3/s (100 gpm). The staff has not identified any significant new information during its independent review of the FPL ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no groundwater use conflicts during the renewal term beyond those discussed in the GEIS.

- Groundwater quality degradation (saltwater intrusion). Based on information in the GEIS, the Commission found that

  "Nuclear power plants do not contribute significantly to saltwater intrusion."

  The staff has not identified any significant new information during its independent review of the FPL ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no groundwater quality degradation impacts associated with saltwater intrusion during the renewal term beyond those discussed in the GEIS.

- Groundwater quality degradation (cooling ponds in salt marshes). Based on information in the GEIS, the Commission found that

  "Sites with closed-cycle cooling ponds may degrade ground-water quality. Because water in salt marshes is brackish, this is not a concern for plants located in salt marshes."

  The staff has not identified any significant new information during its independent review of the FPL ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no groundwater quality degradation impacts associated with cooling ponds in salt marshes during the renewal term beyond those discussed in the GEIS.

There are no Category 2 issues related to groundwater use and quality for Turkey Point Units 3 and 4.

4.6 Threatened or Endangered Species

Threatened or endangered species are listed as a Category 2 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. This issue is listed in Table 4-9.

This issue requires consultation with appropriate agencies to determine whether threatened or endangered species are present and whether they would be adversely affected by continued operation of the nuclear plant during the license renewal term. The presence of threatened or endangered species in the vicinity of the Turkey Point site is discussed in Sections 2.2.5 and 2.2.6.

Assessment of potential impacts was initiated by FPL on September 7, 1999 with letters to FWS and National Marine Fisheries Service (NMFS) (Hovey 1999b; 1999c). Assessment of potential impacts on State species of concern was also initiated by FPL on September 7, 1999 with a letter to FFWCC (Hovey 1999d). The three letters requested information on any deficiencies, concerns, or data needed related to the consultation process. In response to FPL's letter, the FWS identified the requirement for consultation by the Federal action agency, identified recent studies by FPL on the American crocodile, described the importance of FPL's conservation activities on American crocodile recovery in south Florida, and provided a table of Federally listed and candidate species and designated critical habitats in south Florida by county (Slack 2000). The NMFS responded to FPL's letter with a conclusion that the proposed action is not p.m. Eastern Standard Time on Tuesday, July 23, 2002. They should be addressed to Director, National Institute of Corrections, 320 First Street, NW., Room 5007, Washington, DC 20534. The NIC application number should be written on the outside of the mail or courier envelope. Applicants are encouraged to use Federal Express, UPS, or similar service to ensure delivery by due date as the mail at the National Institute of Corrections is still being delayed due to recent decontamination procedures implemented after recent events. Applications mailed or express delivery should be sent to: National Institute of Corrections, 320 First Street, NW, Room 5007, Washington, DC 20534, Attn: Director. Hand delivered applications can be brought to 500 First Street, NW, Washignton, DC 20534. The security officer will call our front desk at 307–3106 to come to the security desk for pickup. Faxed or e-mailed applications will not be accepted.

Addresses and Further Information: A copy of this announcement and applications forms may be obtained through the NIC web site: http://www.nicic.org (under ''Additional Opportunities'' click on the title of this cooperative agreement.) Requests for a hard copy of the application forms, and announcement should be directed to Judy Evens, Cooperative Agreement Control Office, National Institute of Corrections, 320 First Street, NW., Room 5007, Washington, DC 20534 or by calling (800) 995–6423, extension 44222 or (202) 307–3106, extension 44222. She can also be contacted by E-mail via *jevens@bop.gov.*

All technical and or programmatic questions concerning this announcement should be directed to BeLinda P. Watson at the above address or by calling (800) 995–6423, extension 30483 or (202) 353–0483, or by E-mail via *bpwatson@bop.gov.*

Eligible Applicants: An eligible applicant is any state or general unit of local government, private agency, educational institution, organization, individuals or team with expertise in requested areas.

Review Considerations: Applications received under this announcement will be subjected to a 3 to 5 person Peer Review Process.

Number of Awards: One (1).

NIC Application Number: 021P11. This number should appear as a reference line in the cover letter and also in box 11 of Standard Form 424 and outside the envelope in which the application is sent.

Executive Order 12372: This program is not subject to the provisions of Executive Order 12372.

The Catalog of Federal Domestic Assistance number is 16.601: Corrections—Training and Staff Development.

Dated: June 7, 2002.

Larry Solomon,

Deputy Director, National Institute of Corrections.

[FR Doc. 02–14852 Filed 6–12–02; 8:45 am]

BILLING CODE 4410–36–M

DEPARTMENT OF LABOR

Occupational Safety and Health Administration

Susan Harwood Training Grant Program, FY 2002 Budget; Revised Notice

AGENCY: Occupational Safety and Health Administration (OSHA), Labor.

ACTION: Extension of grant application deadline.

SUMMARY: This notice extends the Susan Harwood Training Grant Program application deadline from June 21, 2002, to July 5, 2002.

The notice of availability of funds and request for grant applications was originally published in the **Federal Register**, 67 FR 36024, May 22, 2002. Organizations interested in submitting a grant application should refer to the May 22 **Federal Register** notice which describes the scope of the grant program and provides information about how to get detailed grant application instructions. Applications should not be submitted without the applicant first obtaining detailed grant application instructions.

DATES: Grant application deadline is Friday, July 5, 2002. Grant applications must be received in the Des Plaines, Illinois, office by 4:30 p.m. Central Time, Friday, July 5, 2002.

ADDRESSES: Submit one signed original and three copies of each grant application to the attention of Grants Officer, U. S. Department of Labor, OSHA Office of Training and Education, Division of Training and Educational Programs, 1555 Times Drive, Des Plaines, Illinois 60018.

FOR FURTHER INFORMATION CONTACT: Ernest Thompson, Chief, Division of Training and Educational Programs, or Cynthia Bencheck, Program Analyst, OSHA Office of Training and Education, 1555 Times Drive, Des Plaines, Illinois 60018, telephone (847) 297–4810. This is not a toll-free number. E-mail *cindy.bencheck@osha.gov.*

The Occupational Safety and Health Act of 1970 and the Departments of Labor, Health and Human Services, and Education, and Related Agencies Appropriation Act, Pub. L. 107–116, authorize this program.

Signed at Washington, DC, this 7th day of June 2002.

John L. Henshaw,

Assistant Secretary of Labor.

[FR Doc. 02–14953 Filed 6–12–02; 8:45 am]

BILLING CODE 4510–26–P

NUCLEAR REGULATORY COMMISSION

[Docket Nos. 50–250 and 50–251]

Florida Power and Light Company, Turkey Point Nuclear Generating Units Nos. 3 and 4; Notice of Issuance of Renewed Facility Operating Licenses Nos. DPR–31 and DPR–41 for an Additional 20-Year Period

Notice is hereby given that the U.S. Nuclear Regulatory Commission (the Commission) has issued Renewed Facility Operating Licenses Nos. DPR–31 and DPR–41 to Florida Power and Light Company (the licensee), the operator of the Turkey Point Nuclear Generating Units Nos. 3 and 4 (Turkey Point Units 3 and 4). Renewed Facility Operating License No. DPR–31 authorizes operation of the Turkey Point Unit 3, by the licensee at reactor core power levels not in excess of 2300 megawatts thermal in accordance with the provisions of the Unit 3 renewed license and its Technical Specifications. Renewed Facility Operating License No. DPR–41 authorizes operation of the Turkey Point Unit 4, by the licensee at reactor core power levels not in excess of 2300 megawatts thermal in accordance with the provisions of the Unit 4 renewed license and its Technical Specifications.

The Turkey Point Units 3 and 4 are pressurized water nuclear reactors located in Miami-Dade County east of Florida City, Florida.

The application for the renewed licenses complied with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's regulations. The Commission has made appropriate findings as required by the Act and the Commission's regulations in 10 CFR chapter I, which are set forth in each license. Prior public notice of the action involving the proposed issuance of these renewed licenses and of an opportunity for a hearing regarding the proposed issuance of these renewed licenses was published in the **Federal Register** on October 12, 2000 (65 FR 60693).

For further details with respect to this action, see (1) the Florida Power and Light Company's License Renewal Application for Turkey Point, Units 3 and 4, dated September 8, 2000, as supplemented by letters dated January 19, February 8, February 16, February 26, March 22 (two letters), March 30 (four letters), April 19 (three letters), May 3, May 11 (two letters), May 29 (two letters), June 25, July 18, August 13, November 1, November 7, and December 17, 2001, and April 19, 2002; (2) the Commission's Safety Evaluation Report, dated February 27, 2001, and April 2002 (NUREG–1759), and Supplement 1 thereto, dated May 2002; (3) the licensee's updated final safety analysis report; and (4) the Commission's Final Environmental Impact Statement (NUREG–1437, Supplement 5), dated January 2002. These documents are available at the NRC's Public Document Room, at One White Flint North, 11555 Rockville Pike, first floor, Rockville, Maryland 20852, and can be viewed from the NRC Public Electronic Reading Room at *http://www.nrc.gov/NRC/ADAMS/index.html.*

Copies of Renewed Facility Operating Licenses Nos. DPR–31 and DPR–41 may be obtained by writing to U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001, Attention: Director, Division of Regulatory Improvement Programs. Copies of the Safety Evaluation Report (NUREG–1759), and Supplement 1 thereto, and the Final Environmental Impact Statement (NUREG–1437, Supplement 5) may be purchased from the National Technical Information Service, Springfield, Virginia 22161–0002 at 1–800–553–6847, (*http://www.ntis.gov*), or the Superintendent of Documents, U.S. Government Printing Office, P.O. Box 371954, Pittsburgh, PA 15250–7954 at 202–512–1800, (*http://www.access.gpo.gov/su_docs*). All orders should clearly identify the NRC publication number and the requestor's Government Printing Office deposit account number or VISA or MasterCard number and expiration date.

Dated at Rockville, Maryland, this 6th day of June, 2002.

For the Nuclear Regulatory Commission.

Rajendar Auluck,

Senior Project Manager, License Renewal and Environmental Impacts Program, Division of Regulatory Improvement Programs, Office of Nuclear Reactor Regulation.

[FR Doc. 02–14907 Filed 6–12–02; 8:45 am]

BILLING CODE 7590–01–P

OFFICE OF MANAGEMENT AND BUDGET

Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by the Office of Management and Budget

AGENCY: Office of Management and Budget.

ACTION: Notice of guidelines and request for comments.

SUMMARY: The Office of Management and Budget (OMB) is extending the comment period regarding its draft Information Quality Guidelines from June 14, 2002, to July 1, 2002. OMB is also announcing an extension of the date by which agencies have to submit their draft final information quality guidelines to OMB from no later than July 1, 2002, to no later than August 1, 2002. OMB encourages agencies to use thus extra time to provide the public with additional time to comment on their draft guidelines.

DATES: Written comments regarding OMB's draft Information Quality Guidelines are due by July 1, 2002.

ADDRESSES: Please submit comments to Jefferson B. Hill of the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503. Comments can also be e-mailed to *informationquality@omb.eop.gov.*

FOR FURTHER INFORMATION CONTACT: Jefferson B. Hill, Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503. Telephone: (202) 395–3176.

SUPPLEMENTARY INFORMATION: On May 1, 2002 (67 FR 21779), OMB announced it was seeking comments on its draft Information Quality Guidelines by June 14, 2002. OMB is now extending that comment period to July 1, 2002. These Information Quality Guidelines describe OMB's pre-dissemination information quality control and an administrative mechanism for requests for correction of information publicly disseminated by OMB. The draft Information Quality Guidelines are posted on OMB's Web site, *http://www.whitehouse.gov/omb/inforeg/index.html.*

On January 3, 2002 (67 FR 369), with a correction published on February 22, 2002 (67 FR 8452), OMB published government-wide Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies. Paragraph IV.5 of these Guidelines calls upon each agency Ano later than July 1, 2002,'' to submit the agency's draft final information quality guidelines to OMB for review regarding the consistency of its guidelines with OMB's January 3 government-wide Guidelines. OMB is extending this deadline to no later than August 1, 2002.

This extension of the July 1 deadline to August 1 provides agencies additional time to seek public comment on their proposed information quality guidelines, and to reconsider their draft guidelines in light of the public comments they do receive.

Dated: June 6, 2002.

John D. Graham,

Administrator, Office of Information and Regulatory Affairs.

[FR Doc. 02–14843 Filed 6–12–02; 8:45 am]

BILLING CODE 3110–01–P

SECURITIES AND EXCHANGE COMMISSION

[Rel. No. IC–25606 ; 812–12766]

Touchstone Investment Trust, et al.; Notice of Application

June 6, 2002.

AGENCY: Securities and Exchange Commission (''Commission'').

ACTION: Notice of application for an order under section 6(c) of the Investment Company Act of 1940 (the ''Act'') for an exemption from section 15(a) of the Act and rule 18f-2 under the Act.

Summary of Application: Applicants request an order that would permit them to enter into and materially amend subadvisory agreements without shareholder approval. *Applicants:* Touchstone Investment Trust (''TINT''), Touchstone Strategic Trust (''TST''), Touchstone Tax-Free Trust (''TTFT'') and Touchstone Variable Series Trust (''TVST'') (TINT, TST, TTFT and TVST each a ''Trust'', and collectively, the ''Trusts'') and Touchstone Advisors, Inc. (the ''Adviser'').

Filing Dates: The application was filed on January 29, 2002 and amended on June 5, 2002.

Hearing or Notification of Hearing: An order granting the requested relief will be issued unless the Commission orders a hearing. Interested persons may request a hearing by writing to the Commission's Secretary and serving applicants with a copy of the request, personally or by mail. Hearing requests should be received by the Commission by 5:30 p.m. on July 1, 2002 and should be accompanied by proof of service on applicants, in the form of an affidavit or, for lawyers, a certificate of service.

Proposed Rules

Federal Register

Vol. 74, No. 146

Friday, July 31, 2009

NUCLEAR REGULATORY COMMISSION

10 CFR Part 51

RIN 3150–AI42

[NRC–2008–0608]

Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses

AGENCY: Nuclear Regulatory Commission.

ACTION: Proposed rule.

SUMMARY: The Nuclear Regulatory Commission (NRC) is proposing to amend its environmental protection regulations by updating the Commission's 1996 findings on the environmental impacts related to the renewal of a nuclear power plant's operating license. The Commission stated that it intends to review the assessment of impacts and update it on a 10-year cycle, if necessary. The proposed rule redefines the number and scope of the environmental impact issues which must be addressed by the Commission in conjunction with the review of applications for license renewal. As part of this 10-year update, the NRC revised the 1996 *Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants.* Concurrent with the amendments described in this proposed rule, the NRC is publishing for comment the revised GEIS, a revised Regulatory Guide 4.2, Supplement 1, *Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications,* and a revised Environmental Standard Review Plan, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal*.

DATES: Comments on this proposed rule, its information collection aspects and its draft regulatory analysis should be submitted by October 14, 2009. Comments on the revised GEIS (NUREG–1437, Revision 1); Regulatory Guide (RG) 4.2, Supplement 1, Revision 1; and Environmental Standard Review Plan (ESRP), Supplement 1, Revision 1 (NUREG–1555), should be submitted by October 14, 2009.

ADDRESSES: Comments may be submitted by letter or electronic mail and will be made available for public inspection. Because comments will not be edited to remove any identification or contact information, such as name, addresses, telephone number, e-mail address, *etc.,* the NRC cautions against including any personal information in your submissions that you do not want to be publicly disclosed. The NRC requests that any party soliciting or aggregating comments received from other persons for submission to the NRC inform these persons that the NRC will not edit their comments to remove any identifying or comment information, and therefore, they should not include any information in their comments that they do not want publicly disclosed.

Federal eRulemaking Portal: Go to *http://www.regulations.gov* and search for documents filed under Docket ID [NRC–2008–0608]. Address questions about NRC dockets to Carol Gallagher, (301) 492–3668; e-mail *Carol.Gallagher@nrc.gov*.

Mail comments to: Secretary, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001, ATTN: Rulemakings and Adjudications Staff.

E-mail comments to: Rulemaking.Comments@nrc.gov. If you do not receive a reply e-mail confirming that we have received your comments, contact us directly at (301) 415–1677.

Fax comments to: Secretary, U.S. Nuclear Regulatory Commission at (301) 415–1101.

Publicly available documents related to this rulemaking may be accessed using the following methods:

NRC's Public Document Room (PDR): Publicly available documents may be examined at the NRC's PDR, Public File Area O1–F21, One White Flint North, 11555 Rockville Pike, Rockville, Maryland. The PDR reproduction contractor will copy documents for a fee.

NRC's Agencywide Document Access and Management System (ADAMS): Publicly available documents created or received at the NRC are available electronically at the NRC's Electronic Reading Room at *http://www.nrc.gov/reading-rm/adams.html*. From this link, the public can gain entry into ADAMS, which provides text and image files of NRC's public documents. If problems are encountered accessing documents in ADAMS, contact the NRC's PDR reference staff at (800) 397–4209, or (301) 415–4737, or by e-mail to *PDR.resource@nrc.gov*.

FOR FURTHER INFORMATION CONTACT: Mr. Jason Lising, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001; telephone (301) 415–3220; e-mail: *Jason.Lising@nrc.gov*; or Ms. Jennifer Davis, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001; telephone (301) 415–3835; e-mail: *Jennifer.Davis@nrc.gov*.

SUPPLEMENTARY INFORMATION:

I. Introduction

The NRC is proposing to amend Title 10, Part 51, ''Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions,'' of the *Code of Federal Regulations* (10 CFR Part 51) by updating Table B–1 in Appendix B to Subpart A of ''Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants,'' and other related provisions in Part 51 (*e.g.,* § 51.53(c)(3)), which describes the requirements for the license renewal applicant's environmental report. These amendments are based on comments received from the public on NUREG–1437, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants'' (May 1996), referred to as the ''1996 GEIS,'' and its Addendum 1 (August 1999), a review of plant-specific supplemental environmental impact statements (SEISs) completed since the GEIS was issued in 1996, lessons learned, and knowledge gained from the preparation of these SEISs. The NRC staff has prepared a draft revision to the 1996 GEIS, referred to as the ''revised GEIS,'' which updates the 1996 GEIS based upon consideration of the above described factors. The revised GEIS provides the technical basis for this proposed rule.

In the 1996 GEIS and final rule (61 FR 28467, June 5, 1996), which promulgated Table B–1 and related provisions in Part 51, the Commission determined that certain environmental impacts associated with the renewal of a nuclear power plant operating license were the same or similar for all plants and as such, could be treated on a generic basis. In this way, repetitive reviews of these environmental impacts could be avoided. The Commission based its generic assessment of certain environmental impacts on the following factors:

(1) License renewal will involve nuclear power plants for which the environmental impacts of operation are well understood as a result of lessons learned and knowledge gained from operating experience and completed license renewals.

(2) Activities associated with license renewal are expected to be within this range of operating experience; thus, environmental impacts can be reasonably predicted.

(3) Changes in the environment around nuclear power plants are gradual and predictable.

The 1996 GEIS improved the efficiency of the license renewal process by (1) providing an evaluation of the types of environmental impacts that may occur from renewing commercial nuclear power plant operating licenses; (2) identifying and assessing impacts that are expected to be generic (*i.e.,* the same or similar) at all nuclear plants or plants with specified plant or site characteristics; and (3) defining the number and scope of environmental impacts that need to be addressed in plant-specific SEISs.

As stated in the 1996 final rule that incorporated the findings of the GEIS in Part 51, the NRC recognized that the assessment of the environmental impact issues might change over time, and that additional issues may be identified for consideration. This proposed rule is the result of the 10-year review conducted by the NRC on the information and findings currently presented in Table B–1 of Appendix B to Part 51.

II. Background

Rulemaking History

In 1986, the NRC initiated a program to develop license renewal regulations and associated regulatory guidance in anticipation of applications for the renewal of nuclear power plant operating licenses. A solicitation for comments on the development of a policy statement was published in the **Federal Register** on November 6, 1986 (51 FR 40334). However, the Commission decided to forgo the development of a policy statement and to proceed directly to rulemaking. An advance notice of proposed rulemaking was published on August 29, 1988 (53 FR 32919). Subsequently, in addition to a decision to proceed with the development of license renewal regulations focused on the protection of health and safety, the NRC decided to amend its environmental protection regulations in Part 51.

On October 13, 1989 (54 FR 41980), the NRC published a notice of its intent to hold a public workshop on license renewal on November 13 and 14, 1989. One of the workshop sessions was devoted to the environmental issues associated with license renewal and the possible merit of amending 10 CFR Part 51. The workshop is summarized in NUREG/CP–0108, ''Proceedings of the Public Workshop on Nuclear Power Plant License Renewal'' (April 1990). Responses to the public comments submitted after the workshop are summarized in NUREG–1411, ''Response to Public Comments Resulting from the Public Workshop on Nuclear Power Plant License Renewal'' (July 1990).

On July 23, 1990, the NRC published an advance notice of proposed rulemaking (55 FR 29964) and a notice of intent to prepare a generic environmental impact statement (55 FR 29967). The proposed rule published on September 17, 1991 (56 FR 47016), described the supporting documents that were available and announced a public workshop to be held on November 4 and 5, 1991. The supporting documents for the proposed rule included:

(1) NUREG–1437, ''Draft Generic Environmental Impact Statement for License Renewal of Nuclear Plants'' (August 1991);

(2) NUREG–1440, ''Regulatory Analysis of Proposed Amendments to Regulations Concerning the Environmental Review for Renewal of Nuclear Power Plant Operating Licenses: Draft Report for Comment'' (August 1991);

(3) Draft Regulatory Guide DG–4002, Proposed Supplement 1 to Regulatory Guide 4.2, ''Guidance for the Preparation of Supplemental Environmental Reports in Support of an Application To Renew a Nuclear Power Station Operating License'' (August 1991); and

(4) NUREG–1429, ''Environmental Standard Review Plan for the Review of License Renewal Applications for Nuclear Power Plants: Draft Report for Comment'' (August 1991).

After the comment period, the Commission directed the NRC staff to discuss concerns raised by a number of States that certain features of the proposed rule conflicted with State regulatory authority over the need for power and utility economics. To facilitate these discussions, the NRC developed an options paper entitled, ''Addressing the Concerns of States and Others Regarding the Role of Need for Generating Capacity, Alternative Energy Sources, Utility Costs, and Cost-Benefit Analysis in NRC Environmental Reviews for Relicensing Nuclear Power Plants: An NRC Staff Discussion Paper.'' A **Federal Register** document published on January 18, 1994 (59 FR 2542), announced the scheduling of three regional workshops in February 1994 and the availability of the options paper. A fourth public meeting was held in May 1994 to address proposals that had been submitted after the regional workshops. After consideration of all comments, the NRC issued a supplement to the proposed rule on July 25, 1994 (59 FR 37724), to resolve concerns about the need for power and utility economics.

The NRC published the final rule, ''Environmental Review for Renewal of Nuclear Power Plant Operating Licenses,'' on June 5, 1996 (61 FR 28467). The final rule identified and assessed license renewal environmental impact issues for which a generic analysis had been performed and therefore, did not have to be addressed by a licensee in its environmental report or by the NRC staff in its SEIS. Similarly, the final rule identified and assessed those environmental impacts for which a site-specific analysis was required, both by the licensee in its environmental report and by the NRC staff in its SEIS. The final rule, amongst other amendments to Part 51, added Appendix B to Subpart A of Part 51. Appendix B included Table B–1, which summarizes the findings of NUREG–1437, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants,'' May 1996 (1996 GEIS).

On December 18, 1996 (61 FR 66537), the NRC amended the final rule published in June 1996 to incorporate minor clarifying and conforming changes and add language omitted from Table B–1. This amendment also analyzed comments received specific to the treatment of low-level waste storage and disposal impacts, the cumulative radiological effects from the uranium fuel cycle, and the effects from the disposal of high-level waste and spent fuel requested in the June 1996 final rule.

On September 3, 1999 (64 FR 48496), the NRC amended the December 1996 final rule to expand the generic findings about the environmental impacts resulting from transportation of fuel and waste to and from a single nuclear power plant. This amendment permitted the NRC to make a generic finding regarding these environmental impacts so that an analysis would not have to be repeated for each license renewal application. The amendment also incorporated rule language consistent with the findings in the 1996 GEIS, which addressed local traffic impacts attributable to continued operations of the nuclear power plant during the license renewal term. The *Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Main Report Section 6.3—''Transportation,'' Table 9.1, ''Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants,'' Final Report* (NUREG–1437, Volume 1, Addendum 1), published in August 1999, provides the analysis supporting the amendment.

The current proposed rulemaking began in June 2003 when the NRC issued a notice of intent to update the 1996 GEIS in the **Federal Register** (68 FR 33209). The original comment period began in June 2003 and ended in September 2003. In October 2005 the scoping period was reopened until December 30, 2005 (70 FR 57628).

III. Public Comments

Scoping Process

On June 3, 2003 (68 FR 33209), the NRC solicited public comments which provided the public with an opportunity to participate in the environmental scoping process, as defined in § 51.26. In this notice, the NRC announced the intent to update the 1996 GEIS. The NRC conducted scoping meetings in each of the four NRC regions for the GEIS update. The scoping meetings were held in Atlanta, Georgia (July 8, 2003), Oak Lawn, Illinois (July 10, 2003), Anaheim, California (July 15, 2003), and Boston, Massachusetts (July 17, 2003). The public comment period closed in September 2003 and the project was inactive for the next two years due to limited staff resources and competing demands. On October 3, 2005 (70 FR 57628), the NRC reopened the public comment period and extended it until December 30, 2005. All comments submitted in response to the 2003 scoping request have been considered in preparing the revised GEIS and are publicly available. No comments were received during the 2005 public comment period.

The official transcripts, written comments, and meeting summaries are available electronically for public inspection in the NRC Public Document Room (PDR) or from the Publicly Available Records (PARS) component of NRC's document system under ADAMS Accession Nos. ML032170942, ML032260339, ML032260715, and ML032170934. All comments and suggestions received orally or in writing during the scoping process were considered.

The NRC has prepared a scoping summary report that is available electronically for public inspection in the NRC PDR or from the PARS component of ADAMS under Accession No. ML073450750. Additionally, the scoping summary is located in Appendix A in the revised GEIS.

IV. Discussion

1996 GEIS

Under the NRC's environmental protection regulations in Part 51, which implements Section 102(2) of the National Environmental Policy Act of 1969 (NEPA), renewal of a nuclear power plant operating license requires the preparation of an environmental impact statement (EIS). To help in the preparation of individual operating license renewal EISs, the NRC prepared the 1996 GEIS.

In 1996 and 1999, the Commission amended its environmental protection regulations in Part 51, to improve the efficiency of the environmental review process for applicants seeking to renew a nuclear power plant operating license for up to an additional 20 years. These amendments were based on the analyses reported in the 1996 GEIS.

The 1996 GEIS summarizes the findings of a systematic inquiry into the environmental impacts of continued operations and refurbishment activities associated with license renewal. The NRC identified 92 environmental impact issues. Of the 92 environmental issues analyzed, 69 issues were resolved generically (*i.e.*, Category 1), 21 would require a further plant-specific analysis (*i.e.*, Category 2), and 2 would require a site-specific assessment by the NRC prior to issuance of a renewed license (*i.e.*, uncategorized). As part of a license renewal application, an applicant submits an environmental report to the NRC, and the NRC prepares a plant-specific SEIS to the 1996 GEIS.

The GEIS assigns one of three impact levels (small, moderate, or large) to a given environmental resource (*e.g.*, air, water, or soil). A small impact means that the environmental effects are not detectable, or are so minor that they will neither destabilize, nor noticeably alter, any important attribute of the resource. A moderate impact means that the environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource. A large impact means that the environmental effects are clearly noticeable, and are sufficient to destabilize important attributes of the resource.

Table B–1 in Appendix B to Part 51, summarizes the findings of the analyses conducted for the 1996 GEIS. Issues and processes common to all nuclear power plants having generic (*i.e.*, the same or similar) environmental impacts are considered Category 1 issues. Category 2 issues are those issues that cannot be generically dispositioned and would require a plant-specific analysis to determine the level of impact.

The 1996 GEIS has been effective in focusing NRC resources on important environmental issues and increased the efficiency of the environmental review process. Currently, 51 nuclear units at 29 plant sites have received renewed licenses.

Revised GEIS

The GEIS revision evaluates the environmental issues and findings of the 1996 GEIS. Lessons learned and knowledge gained during previous license renewal reviews provided a significant source of new information for this assessment. Public comments on previous plant-specific license renewal reviews were analyzed to assess the existing environmental issues and identify new ones. The purpose of this evaluation was to determine if the findings presented in the 1996 GEIS remain valid. In doing so, the NRC considered the need to modify, add to, or delete any of the 92 environmental issues in the 1996 GEIS. After this evaluation, the staff carried forward 78 impact issues for detailed consideration in this GEIS revision. Fifty-eight of these issues were determined to be Category 1 and would not require additional plant-specific analysis. Of the remaining twenty issues, nineteen were determined to be Category 2 and one remained uncategorized. No environmental issues identified in Table B–1 and in the 1996 GEIS were eliminated, but several were combined or regrouped according to similarities.

Environmental issues in the revised GEIS are arranged by resource area. This perspective is a change from the 1996 GEIS in which environmental issues were arranged by power plant systems (*e.g.*, cooling systems, transmission lines) and activities (*e.g.*, refurbishment). The structure of the revised GEIS adopts the NRC's standard format for EISs as established in Part 51, Appendix A to Subpart A of Part 51—''Format for Presentation of Material in Environmental Impact Statements.'' The environmental impacts of license renewal activities, including plant operations and refurbishment along with replacement power alternatives, are addressed in each resource area. The revised GEIS summarizes environmental impact issues under the following resource areas: (1) Land use and visual resources; (2) meteorology, air quality, and noise; (3) geology, seismology, and soils; (4) hydrology (surface water and groundwater); (5) ecology (terrestrial ecology, aquatic ecology, threatened, endangered, and protected species and essential fish habitat); (6) historic and cultural resources; (7) socioeconomics; (8) human health (radiological and nonradiological hazards); (9) environmental justice; and (10) waste management and pollution prevention. The proposed rule revises Table B–1 in Appendix B to Subpart A of Part 51 to follow the organizational format of the revised GEIS.

Environmental impacts of license renewal and the resources that could be affected were identified in the revised GEIS. The general analytical approach for identifying environmental impacts was to (1) describe the nuclear power plant activity that could affect the resource, (2) identify the resource that is affected, (3) evaluate past license renewal reviews and other available information, (4) assess the nature and magnitude of the environmental impact on the affected resource, (5) characterize the significance of the effects, (6) determine whether the results of the analysis apply to all nuclear power plants (whether the impact issue is Category 1 or Category 2), and (7) consider additional mitigation measures for adverse impacts. Identification of environmental impacts (or issues) was conducted in an iterative rather than a stepwise manner. For example, after information was collected and levels of significance were reviewed, impacts were reexamined to determine if any should be removed, added, recombined, or divided.

The Commission would like to emphasize that in complying with the NRC's environmental regulations under § 51.53(c)(3)(iv) applicants are required to provide any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware, even on Category 1 issues. The proposed amendments would not change this requirement.

The revised GEIS retains the 1996 GEIS definitions of a Category 1 and Category 2 issue. The revised GEIS discusses four major types of changes:

(1) *New Category 1 Issue:* These issues would include Category 1 issues not previously listed in the 1996 GEIS or multiple Category 1 issues from the 1996 GEIS that have been combined into a Category 1 issue in the revised GEIS. The applicant does not need to assess this issue in its environmental report. Under § 51.53(c)(3)(iv), however, the applicant is responsible for reporting in the environmental report any ''new and significant information'' of which the applicant is aware. If the applicant is not aware of any new and significant information that would change the conclusion in the revised GEIS, the applicant would be required to state this determination in the environmental report. The NRC has addressed the environmental impacts of these Category 1 issues generically for all plants in the revised GEIS.

(2) *New Category 2 Issue:* These issues would include Category 2 issues not previously listed in the 1996 GEIS or multiple Category 2 issues from the 1996 GEIS that have been combined into a Category 2 issue in the revised GEIS. For each new Category 2 issue, the applicant would have to conduct an assessment of the potential environmental impacts related to that issue and include it in the environmental report. The assessment must include a discussion of (i) the possible actions to mitigate any adverse impacts associated with license renewal and (ii) the environmental impacts of alternatives to license renewal.

(3) *Existing Issue Category Change from Category 2 to Category 1:* These would include issues that were considered as Category 2 in the 1996 GEIS and would now be considered as Category 1 in the revised GEIS. An applicant would no longer be required to conduct an assessment on the environmental impacts associated with these issues. Consistent with the requirements of § 51.53(c)(3)(iv), an applicant would only be required to describe in its environmental report any ''new and significant information'' of which it is aware.

(4) *Existing Issue Category Change from Category 1 to Category 2:* These would include issues that were considered as Category 1 in the 1996 GEIS and would now be considered as Category 2 in the revised GEIS. An applicant that previously did not have to provide an analysis on the environmental impacts associated with these issues would now be required to conduct an assessment of the environmental impacts and include it in the environmental report.

V. Proposed Actions and Basis for Changes to Table B–1

The revised GEIS which is concurrently issued for public comment and publicly available (ADAMS Accession No. ML090220654) provides a summary change table comparing the ninety-two environmental issues in the 1996 GEIS with the seventy-eight environmental issues in the revised GEIS. The proposed rule amends Table B–1 in Appendix B to Subpart A, ''Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants,'' to reflect the changes made in the revised GEIS. The changes to Table B–1 are described below:

(i) Land Use

(1) *Onsite Land Use*—''Onsite land use'' remains a Category 1 issue. The proposed rule makes minor clarifying changes to the finding column of Table B–1 for this issue.

(2) *Offsite Land Use*—The proposed rule language combines two Category 2 issues, ''Offsite land use (refurbishment)'' and ''Offsite land use (license renewal term)'' reclassifies this combined issue as a Category 1 issue, and names it, ''Offsite land use.'' The finding column of the current Table B–1 for ''Offsite land use (refurbishment)'' indicates that impacts may be of moderate significance at plants in low population areas. The finding column of the current Table B–1 for ''Offsite land use (license renewal term)'' indicates that significant changes in land use may be associated with population and tax revenue changes resulting from license renewal. As described in the 1996 GEIS, environmental impacts are considered to be small if refurbishment activities were to occur at plants located in high population areas and if population and tax revenues would not change.

Significant impacts on offsite land use are not anticipated. Previous plant-specific license renewal reviews conducted by the NRC have shown no requirement for a substantial number of additional workers during the license renewal term and that refurbishment activities, such as steam generator and vessel head replacement, have not required the large numbers of workers and the months of time that was conservatively estimated in the 1996 GEIS. These reviews support a finding that offsite land use impacts during the license renewal term would be small for all nuclear power plants.

(3) *Offsite Land Use in Transmission Line Rights-of-Way (ROWs)*—The proposed rule renames ''Powerline right of way'' as ''Offsite land use in transmission line rights-of-way (ROWs);'' it remains a Category 1 issue. The proposed rule makes minor clarifying changes to the finding column of Table B–1 for this issue.

(ii) Visual Resources

(4) *Aesthetic Impacts*—The proposed rule language combines three Category 1 issues, ''Aesthetic impacts (refurbishment),'' ''aesthetic impacts (license renewal term),'' and ''aesthetic impacts of transmission lines (license renewal term)'' into one new Category 1 issue, ''Aesthetic impacts.'' The 1996 GEIS concluded that renewal of operating licenses and the refurbishment activities would have no significant aesthetic impact during the license renewal term. Impacts are considered to be small if the visual appearance of plant and transmission line structures would not change. Previous license renewal reviews conducted by the NRC show that the appearance of nuclear plants and transmission line structures do not change significantly over time or because of refurbishment activities. Therefore, aesthetic impacts are not anticipated and the combined issue remains a Category 1 issue.

These three issues are combined into one Category 1 issue as they are similar and combining them would streamline the license renewal process.

(iii) Air Quality

(5) *Air Quality (Non-Attainment and Maintenance Areas)*—The proposed language renames ''Air quality during refurbishment (non-attainment and maintenance areas)'' as ''Air quality (non-attainment and maintenance areas)'' and expands it to include emissions from testing emergency diesel generators, boilers used for facility heating, and particulate emissions from cooling towers. The issue remains a Category 2 issue.

(6) *Air Quality Effects of Transmission Lines*—''Air quality effects of transmission lines'' remains a Category 1 issue. There are no changes for this issue.

(iv) Noise

(7) *Noise Impacts*—The proposed rule renames ''Noise'' as ''Noise impacts''; it remains a Category 1 issue. The proposed rule makes minor clarifying changes to the finding column of Table B–1 for this issue.

(v) Geology and Soils

(8) *Impacts of Nuclear Plants on Geology and Soils*—The proposed language adds a new Category 1 issue, ''Impacts of nuclear plants on geology and soils,'' to the impacts of continued power plant operations and refurbishment activities on geology and soils (*i.e.*, prime farmland) and to determine if there is new or significant information in regard to regional or local seismology. New seismological conditions are limited to the identification of previously unknown geologic faults and are expected to be rare. Geology and soil conditions at all nuclear power plants and associated transmission lines have been well established during the current licensing term and are expected to remain unchanged during the 20-year license renewal term. The impact of continued operations and refurbishment activities during the license renewal term on geologic and soil resources would consist of soil disturbance for construction or renovation projects. Implementing best management practices would reduce soil erosion and subsequent impacts on surface water quality. Best management practices include: (1) Minimizing the amount of disturbed land, (2) stockpiling topsoil before ground disturbance, (3) mulching and seeding in disturbed areas, (4) covering loose materials with geotextiles, (5) using silt fences to reduce sediment loading to surface water, (6) using check dams to minimize the erosive power of drainages, and (7) installing proper culvert outlets to direct flows in streams or drainages.

No information in any plant-specific SEIS prepared to date, or in the referenced documents, has identified these impacts as being significant.

(vi) Surface Water

(9) *Surface-Water Use and Quality*—The proposed rule combines two Category 1 issues, ''Impacts of refurbishment on surface water quality'' and ''Impacts of refurbishment on surface water use,'' and names the combined issue ''Surface-water use and quality.'' These two issues were combined because the impacts of refurbishment on both surface water use and quality are negligible and the effects are closely related.

The NRC expects licensees to use best management practices during the license renewal term for both continuing operations and refurbishment activities. Use of best management practices will minimize soil erosion. In addition, implementation of spill prevention and control plans will reduce the likelihood of any liquid chemical spills. If refurbishment activities take place during a reactor shutdown, the overall water use by the facility will be reduced. Based on this conclusion, the impact on surface water use and quality during a license renewal term will continue to be small for all plants. The combined issue remains a Category 1 issue. The proposed rule makes minor clarifying changes to the finding column of Table B–1 for this issue.

(10) *Altered Current Patterns at Intake and Discharge Structures*, (11) *Altered Salinity Gradients*, (12) *Altered Thermal Stratification of Lakes*, and (13) *Scouring Caused by Discharged Cooling Water*—''Altered current patterns at intake and discharge structures,'' ''Altered salinity gradients,'' ''Altered thermal stratification of lakes,'' and ''Scouring caused by discharged cooling water'' remain Category 1 issues. The proposed rule makes minor clarifying changes to the finding column of Table B–1 for each of these issues.

(14) *Discharge of Metals in Cooling System Effluent*—The proposed language renames ''Discharge of other metals in waste water'' as ''Discharge of metals in cooling system effluent''; it remains a Category 1 issue. The proposed rule makes minor clarifying changes to the finding column of Table B–1 for this issue.

(15) *Discharge of Biocides, Sanitary Wastes, and Minor Chemical Spills*—The proposed rule combines two Category 1 issues, ''Discharge of chlorine or other biocides'' and ''Discharge of sanitary wastes and minor chemical spills'' as ''Discharge of biocides, sanitary wastes, and minor chemical spills.'' The combined issue remains a Category 1 issue. The proposed rule makes minor clarifying changes to the finding column of Table B–1 for this issue.

(16) *Water Use Conflicts (plants with once-through cooling systems)*—''Water use conflicts (plants with once-through cooling systems)'' remains a Category 1 issue. The proposed rule makes a minor clarifying change to the finding column of Table B–1 for this issue.

(17) *Water Use Conflicts (plants with cooling ponds or cooling towers using make-up water from a river with low flow)*—''Water use conflicts (plants with cooling ponds or cooling towers using

make-up water from a river with low flow)'' remains a Category 2 issue. The proposed rule makes minor clarifying changes to the finding column of Table B–1 for this issue.

(18) *Effects of Dredging on Water Quality*—The proposed rule adds a new Category 1 issue, ''Effects of dredging on water quality,'' that evaluates the impacts of dredging to maintain intake and discharge structures at nuclear power plant facilities. The impact of dredging on surface water quality was not considered in the 1996 GEIS and is not listed in the current Table B–1. Most plants have intake and discharge structures that must be maintained by periodic dredging of sediment accumulated in or on the structures.

This dredging, while temporarily increasing turbidity in the source water body, has been shown to have little effect on water quality. In addition to maintaining intake and discharge structures, dredging is often done to keep barge slips and channels open to service the plant. Dredged material is most often disposed on property owned by the applicant and usually contains no hazardous materials. Dredging is performed under a permit issued by the U.S. Army Corps of Engineers and consequently, each dredging action would be subject to a site-specific environmental review conducted by the Corps.

Temporary impacts of dredging are measurable in general water quality terms, but the impacts have been shown to be small.

(19) *Temperature Effects on Sediment Transport Capacity*—''Temperature effects on sediment transport capacity'' remains a Category 1 issue. There are no changes to this issue.

(vii) Groundwater

(20) *Groundwater Use and Quality*—The proposed rule renames ''Impacts of refurbishment on groundwater use and quality'' as ''Groundwater use and quality.'' The issue remains a Category 1 issue. The NRC has concluded that use of best management practices would address any wastes or spills that could affect groundwater quality. The proposed rule updates the finding column of Table B–1 for this issue to include a statement identifying best management practices and makes other minor clarifying changes to the finding column.

(21) *Groundwater Use Conflicts (Plants that Withdraw Less Than 100 Gallons per Minute [gpm])*—The proposed rule renames ''Ground-water use conflicts (potable and service water; plants that use <100 gpm)'' as ''Groundwater use conflicts (plants that withdraw less than 100 gallons per minute [gpm]).'' The issue remains a Category 1 issue. The proposed rule makes minor clarifying changes to the finding column of Table B–1 for this issue.

(22) *Groundwater use conflicts (plants that withdraw more than 100 gpm including those using Ranney Wells)*—The proposed rule combines two Category 2 issues, ''Groundwater use conflicts (potable and service water, and dewatering; plants that use >100 gpm)'' and ''Ground-water use conflicts (Ranney wells)'' and names the combined issue ''Groundwater use conflicts (plants that withdraw more than 100 gpm including those using Ranney wells).'' The combined issue remains a Category 2 issue. Because Ranney wells produce significantly more than 100 gpm, the Ranney wells issue was combined with the general issue of groundwater use conflicts for plants using more than 100 gpm of groundwater. The proposed rule makes clarifying changes to the finding column of Table B–1 for this combined issue.

(23) *Groundwater Use Conflicts (Plants With Closed-Cycle Cooling Systems that Withdraw Makeup Water from a River)*—The proposed rule renames ''Ground-water use conflicts (plants using cooling tower withdrawing make-up water from a small river'' as ''Groundwater use conflicts (plants with closed-cycle cooling systems that withdraw makeup water from a river).'' The combined issue remains a Category 2 issue. The proposed rule makes minor clarifying changes to the finding column of Table B–1 for this issue.

(24) *Groundwater Quality Degradation Resulting from Water Withdrawals*—The proposed rule combines two Category 1 issues, ''Ground-water quality degradation (Ranney wells)'' and ''Ground-water quality degradation (saltwater intrusion)'' and names the combined issue ''Groundwater quality degradation resulting from water withdrawals.'' The combined issue remains a Category 1 issue. The two issues were combined as they both consider the possibility of groundwater quality becoming degraded as a result of the plant drawing water of potentially lower quality into the aquifer. The proposed rule makes clarifying changes to the finding column of Table B–1 for this combined issue.

(25) *Groundwater Quality Degradation (Plants with Cooling Ponds in Salt Marshes)* and (26) *Groundwater Quality Degradation (Plants with Cooling Ponds at Inland Sites)*—''Groundwater quality degradation (plants with cooling ponds in salt marshes)'' and ''Groundwater quality degradation (plants with cooling ponds at inland sites)'' remain, respectively, Category 1 and Category 2 issues. The proposed rule makes clarifying changes to the finding column of Table B–1 for each of these issues.

(27) *Groundwater and Soil Contamination*—The proposed rule adds a new Category 2 issue, ''Groundwater and Soil Contamination,'' to evaluate the impacts of the industrial use of solvents, hydrocarbons, heavy metals, or other chemicals on groundwater, soil, and subsoil at nuclear power plant sites during the license renewal term. Review of license renewal applications has shown the existence of these non-radionuclide contaminants at some plants. This contamination is usually regulated by State environmental regulatory authorities or the Environmental Protection Agency (EPA). In addition, this new Category 2 issue has been added because each specific site has its own program for handling waste and hazardous materials, and no generic evaluation would apply to all nuclear power plants.

Industrial practices at all plants have the potential to contaminate site groundwater and soil through the use and spillage of solvents, hydrocarbons, heavy metals, or other chemicals, especially on sites with unlined wastewater lagoons and storm water lagoons. Any contamination by these substances is subject to characterization and clean-up by State and EPA regulated remediation and monitoring programs.

(28) *Radionuclides Released to Groundwater*—The proposed rule adds a new Category 2 issue, ''Radionuclides released to groundwater,'' to evaluate the potential impact of discharges of radionuclides, such as tritium, from plant systems into groundwater. The issue is relevant to license renewal because virtually all commercial nuclear power plants routinely release radioactive gaseous and liquid materials into the environment. A September 2006 NRC report, ''Liquid Radioactive Release Lessons Learned Task Force Report,'' documented instances of inadvertent releases of radionuclides into groundwater from nuclear power plants (ADAMS Accession No. ML062650312).

NRC regulations in Parts 20 and 50 limit the amount of radioactivity released into the environment to be ''As Low As is Reasonably Achievable'' (ALARA) to ensure that the impact on public health is very low. Most of the inadvertent liquid release events involved tritium, which is a radioactive isotope of hydrogen. However, other radioactive isotopes have been inadvertently released into the environment. An example is leakage from spent fuel pools, where leakage from the stored fuel would allow fission products to be released into the pool water.

The most significant conclusion of the NRC report regards public health impacts. Although there have been a number of events where radionuclides were released inadvertently into groundwater, based on the data available, the NRC did not identify any instances where the health of the public was impacted. The NRC did identify that under the existing regulatory requirements, the potential exists for inadvertent radionuclide releases to migrate offsite into groundwater.

Another factor in adding this new Category 2 issue is the level of public concern associated with such inadvertent releases of radionuclides into groundwater. The NRC concludes that the impact of radionuclide releases to groundwater quality could be small or moderate, depending on the occurrence and frequency of leaks and the ability to respond to leaks in a timely fashion.

(viii) Terrestrial Resources

(29) *Impacts of Continued Plant Operations on Terrestrial Ecosystems*—The proposed rule renames ''Refurbishment impacts'' as ''Impacts of continued plant operations on terrestrial ecosystems;'' it remains a Category 2 issue. The analysis in the revised GEIS expands the scope of this issue to include the environmental impacts associated with continued plant operations and maintenance activities in addition to refurbishment. The proposed rule revises the finding column of Table B–1 for this issue accordingly.

(30) *Exposure of Terrestrial Organisms to Radionuclides*—The proposed rule adds a new Category 1 issue, ''Exposure of terrestrial organisms to radionuclides,'' to evaluate the issue of the potential impact of radionuclides on terrestrial organisms resulting from normal operations of a nuclear power plant during the license renewal term. This issue was not evaluated in the 1996 GEIS. However, the impact of radionuclides on terrestrial organisms has been raised by members of the public as well as Federal and State agencies during previous license renewal reviews.

The revised GEIS evaluates the potential impact of radionuclides on terrestrial biota at nuclear power plants from continued operations during the license renewal term. Site-specific radionuclide concentrations in water, sediment, and soils were obtained from Radiological Environmental Monitoring Operating Reports from 15 nuclear power plants. These 15 plants were selected to represent sites with a range of radionuclide concentrations in the media, including plants with high annual worker dose exposure values for both boiling water reactors and pressurized water reactors. The calculated radiation dose rates to terrestrial biota were compared against radiation-acceptable radiation safety guidelines issued by the U.S. Department of Energy, the International Atomic Energy Agency, the National Council of Radiation Protection and Measurement, and the International Commission on Radiological Protection. The NRC concludes that the impact of radionuclides on terrestrial biota from past and current operations would be small for all nuclear power plants and would not be expected to change appreciably during the license renewal term.

(31) *Cooling System Impacts on Terrestrial Resources (Plants with Once-Through Cooling Systems or Cooling Ponds)*—The proposed rule renames ''Cooling pond impacts on terrestrial resources'' as ''Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds).'' This issue remains a Category 1 issue. The analysis in the revised GEIS expands the scope of this issue to include plants with once-through cooling systems. This analysis concludes that the impacts on terrestrial resources from once-through cooling systems, as well as from cooling ponds, is of small significance at all plants. The proposed rule revises the finding column of Table B–1 for this issue accordingly.

(32) *Cooling Tower Impacts on Vegetation (Plants with Cooling Towers)*—The proposed rule combines two Category 1 issues, ''Cooling tower impacts on crops and ornamental vegetation'' and ''Cooling tower impacts on native plants'' and names the combined issue ''Cooling tower impacts on vegetation (plants with cooling towers).'' The combined issue remains a Category 1 issue. The two issues were combined to conform to the resource-based approach used in the revised GEIS and to simplify and streamline the analysis. With the recent trend of replacing lawns with native vegetation, some ornamental plants and crops are native plants, and the original separation into two issues is unnecessary and cumbersome. The proposed rule makes clarifying changes to the finding column of Table B–1 for this combined issue.

(33) *Bird Collisions with Cooling Towers and Transmission Lines*—The proposed rule combines two Category 1 issues, ''Bird collisions with cooling towers'' and ''Bird collision with power lines'' and names the combined issue ''Bird collisions with cooling towers and transmission lines.'' The combined issue remains a Category 1 issue. The two issues were combined to conform to the resource-based approach used in the revised GEIS and to simplify and streamline the analysis. The proposed rule makes clarifying changes to the finding column of Table B–1 for this combined issue.

(34) *Water Use Conflicts with Terrestrial Resources (Plants with Cooling Ponds or Cooling Towers Using Makeup Water from a River with Low Flow)*—The proposed rule adds a new Category 2 issue, ''Water use conflicts with terrestrial resources (plants with cooling ponds or cooling towers using make-up water from a river with low flow)'' to evaluate water use conflict impacts with terrestrial resources in riparian communities. Such impacts could occur when water that supports these resources is diminished either because of decreased availability due to droughts; increased water demand for agricultural, municipal, or industrial usage; or a combination of these factors. The potential range of impact levels at plants, subject to license renewal, with cooling ponds or cooling towers using makeup water from a small river with low flow cannot be generically determined at this time.

(35) *Transmission Line ROW Management Impacts on Terrestrial Resources*—The proposed rule combines two Category 1 issues, ''Power line right-of-way management (cutting and herbicide application)'' and ''Floodplains and wetland on power line right-of-way'' and names the combined issue ''Transmission line ROW management impacts on terrestrial resources.'' The combined issue remains a Category 1 issue. The two issues were combined to simplify and streamline the analysis.

The scope of the evaluation of transmission lines in the revised GEIS is reduced from that of the 1996 GEIS—only those transmission lines currently needed to connect the nuclear power plants to the regional electrical distribution grid are considered within the scope of license renewal. Thus, the number of and length of transmission lines being evaluated are greatly reduced. The revised GEIS analysis indicates that proper management of transmission line ROW areas does not have significant adverse impacts on current wildlife populations, and ROW management can provide valuable wildlife habitats. The proposed rule makes clarifying changes to the finding column of Table B–1 for this combined issue.

(36) *Electromagnetic Fields on Flora and Fauna (Plants, Agricultural Crops, Honeybees, Wildlife, Livestock)*—''Electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)'' remains a Category 1 issue. There are no changes to this issue.

(ix) Aquatic Resources

(37) *Impingement and Entrainment of Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds)*—The proposed rule combines two Category 2 issues, ''Entrainment of fish and shellfish in early life stages (for plants with once-through cooling and cooling pond heat dissipation systems)'' and ''Impingement of fish and shellfish (for plants with once-through cooling and cooling pond heat dissipation systems)'' and one Category 1 issue, ''Entrainment of phytoplankton and zooplankton (for all plants)'' and names the combined issue ''Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds).'' The combined issue is a Category 2 issue.

For the revised GEIS, these issues were combined to simplify the review process in keeping with the resource-based approach and to allow for a more complete analysis of the environmental impact. Nuclear power plants typically conduct separate sampling programs to estimate the numbers of organisms entrained and impinged, which explains the original separation of these issues. However, it is the combined effects of entrainment and impingement that reflect the total impact of the cooling system intake on the resource. Environmental conditions are different to each nuclear plant site and impacts cannot be determined generically. The proposed rule revises the finding column of Table B–1 for this issue accordingly.

(38) *Impingement and Entrainment of Aquatic Organisms (Plants with Cooling Towers)*—The proposed rule combines three Category 1 issues, ''Entrainment of fish and shellfish in early life stages (for plants with cooling tower-based heat dissipation systems),'' ''Impingement of fish and shellfish (for plants with cooling tower-based heat dissipation systems),'' and ''Entrainment of phytoplankton and zooplankton (for all plants)'' and names the combined issue ''Impingement and entrainment of aquatic organisms (plants with cooling towers).'' The combined issue remains a Category 1 issue. The three issues are combined given their similar nature and to simplify and streamline the review process. The proposed rule revises the finding column of Table B–1 for this issue accordingly.

(39) *Thermal Impacts on Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds)*—The proposed rule combines four Category 1 issues, ''Cold shock (for all plants),'' ''Thermal plume barrier to migrating fish (for all plants),'' ''Distribution of aquatic organisms (for all plants),'' and ''Premature emergence of aquatic insects (for all plants),'' and one Category 2 issue ''Heat shock (for plants with once-through and cooling pond heat dissipation systems)'' and names the combined issue ''Thermal impacts on aquatic organisms (plants with once-through cooling systems or cooling ponds).'' The combined issue is a Category 2 issue.

The five issues are combined given their similar nature and to simplify and streamline the review process. With the exception of heat shock, previous license renewal reviews conducted by the NRC have shown that the thermal effects of once-through cooling and cooling pond systems have not been a problem at operating nuclear power plants and would not change during the license renewal term, so future impacts are not anticipated. However, it is difficult to differentiate the various thermal effects of once-through cooling and cooling pond systems in the field. Different populations may react differently due to changes in water temperature. For example, if a resident population avoided a heated effluent, the 1996 GEIS would have identified this issue as ''distribution of aquatic organisms;'' however, had this population been migrating, the issue would have been considered under ''thermal plume barrier to migrating fish.'' If individuals had remained in the heated effluent too long, the issue would have been considered under ''heat shock;'' or, if the individuals then left the warm water, the issue would have been considered under ''cold shock.'' Using the resource-based approach in the revised GEIS, each of these issues would be considered a thermal impact from once-through and cooling pond systems. Environmental conditions are different at each nuclear plant site and impacts cannot be determined generically. The proposed rule revises the finding column of Table B–1 for this issue accordingly.

(40) *Thermal Impacts on Aquatic Organisms (Plants with Cooling Towers)*—The proposed rule combines five Category 1 issues, ''Cold shock (for all plants),'' ''Thermal plume barrier to migrating fish (for all plants),'' ''Distribution of aquatic organisms (for all plants),'' ''Premature emergence of aquatic insects (for all plants),'' and ''Heat shock (for plants with cooling-tower-based heat dissipation systems)'' and names the combined issue ''Thermal impacts on aquatic organisms (plants with cooling towers).'' The combined issue is a Category 1 issue.

The five issues are combined given their similar nature and to simplify and streamline the review process. The proposed rule revises the finding column of Table B–1 for this issue accordingly.

(41) *Effects of Cooling Water Discharge on Dissolved Oxygen, Gas Supersaturation, and Eutrophication*—The proposed rule combines three Category 1 issues, ''Eutrophication,'' ''Gas supersaturation (gas bubble disease),'' and ''Low dissolved oxygen in the discharge,'' and names the combined issue ''Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication.'' The combined issue is a Category 1 issue.

The three issues are combined given their similar nature and to simplify and streamline the review process. The proposed rule revises the finding column of Table B–1 for this issue accordingly.

(42) *Effects of Non-Radiological Contaminants on Aquatic Organisms*—The proposed rule renames ''Accumulation of contaminants in sediments or biota'' as ''Effects of non-radiological contaminants on aquatic organisms;'' it remains a Category 1 issue. The proposed rule makes clarifying changes to the finding column of Table B–1 for this issue.

(43) *Exposure of Aquatic Organisms to Radionuclides*—The proposed rule adds a new Category 1 issue, ''Exposure of Aquatic Organisms to Radionuclides,'' to evaluate the potential impact of radionuclide discharges upon aquatic organisms. This issue has been raised by members of the public as well as Federal and State agencies during the license renewal process for various plants.

The revised GEIS evaluates the potential impact of radionuclides on aquatic organisms at nuclear power plants from continued operations during the license renewal term. A radiological assessment was performed using effluent release data from 15 NRC-licensed nuclear power plants chosen based on having a range of radionuclide concentrations in environmental media.

Site-specific radionuclide concentrations in water and sediments, as reported in the plant's radioactive effluent and environmental monitoring reports, were used in the calculations. The data is representative of boiling water reactors and pressurized water reactors. The calculated radiation dose rates to aquatic biota were compared against radiation acceptable radiation safety guidelines issued by the U.S. Department of Energy, the International Atomic Energy Agency, the National Council of Radiation Protection and Measurement, and the International Commission on Radiological Protection. The NRC concludes that the impact of radionuclides on aquatic biota from past and current operations would be small for all nuclear power plants, and would not be expected to change appreciably during the license renewal term.

(44) *Effects of Dredging on Aquatic Organisms*—The proposed rule adds a new Category 1 issue, ''Effects of dredging on aquatic organisms,'' to evaluate the impacts of dredging on aquatic organisms. Licensees conduct dredging to maintain intake and discharge structures at nuclear power plant facilities and in some cases, to maintain barge slips. Dredging may disturb or remove benthic communities. In general, maintenance dredging for nuclear power plant operations would occur infrequently, would be of relatively short duration, and would affect relatively small areas. Dredging is performed under a permit issued by the U.S. Army Corps of Engineers and consequently, each dredging action would be subject to a site-specific environmental review conducted by the Corps.

(45) *Water Use Conflicts with Aquatic Resources (Plants with Cooling Ponds or Cooling Towers using Make-Up Water from a River with Low Flow)*—The proposed rule adds a new Category 2 issue, ''Water use conflicts with aquatic resources (plants with cooling ponds or cooling towers using make-up water from a river with low flow)'' to evaluate water use conflict impacts with aquatic resources in instream communities. Such impacts could occur when water that supports these resources is diminished either because of decreased availability due to droughts; increased water demand for agricultural, municipal, or industrial usage; or a combination of these factors. The potential range of impact levels at plants, subject to license renewal, with cooling ponds or cooling towers using makeup water from a small river with low flow cannot be generically determined at this time.

(46) *Refurbishment Impacts on Aquatic Resources*—The proposed rule language renames ''Refurbishment'' as ''Refurbishment impacts on aquatic resources;'' it remains a Category 1 issue. The proposed rule makes minor clarifying changes to the finding column of Table B–1 for this issue.

(47) *Impacts of Transmission Line ROW Management on Aquatic Resources*—The proposed rule adds a new Category 1 issue, ''Impacts of transmission line ROW management on aquatic resources,'' to evaluate the impact of transmission line ROW management on aquatic resources. Impacts on aquatic resources from transmission line ROW maintenance could occur as a result of the direct disturbance of aquatic habitats, soil erosion, changes in water quality (from sedimentation and thermal effects), or inadvertent releases of chemical contaminants from herbicide use. As described in the revised GEIS, any impact on aquatic resources resulting from transmission line ROW management is expected to be small, short term, and localized for all plants.

(48) *Losses from Predation, Parasitism, and Disease Among Organisms Exposed to Sublethal Stresses* and (49) *Stimulation of Aquatic Nuisance Species (e.g., Shipworms)*—''Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses'' and ''Stimulation of aquatic nuisance species (*e.g.*, shipworms)'' remain Category 1 issues. The proposed rule does not change the finding column entries of Table B–1 for these issues.

(x) Threatened, Endangered, and Protected Species and Essential Fish Habitat

(50) *Threatened, Endangered, and Protected Species and Essential Fish Habitat*—The proposed rule renames ''Threatened or endangered species'' as ''Threatened, endangered, and protected species and essential fish habitat'' and expands the scope of the issue to include essential fish habitats protected under the Magnuson-Stevens Fishery Conservation and Management Act. The issue remains a Category 2 issue. The proposed rule makes clarifying changes to the finding column entry of table B–1 for this issue.

(xi) Historic and Cultural Resources

(51) *Historic and Cultural Resources*—The proposed rule language renames ''Historic and archaeological resources'' as ''Historic and cultural resources;'' it remains a Category 2 issue. The proposed rule language more accurately reflects the National Historic Preservation Act requirements that Federal agencies consult with State Historic Preservation Officer and appropriate Native American Tribes to determine the potential impacts and mitigation.

(xii) Socioeconomics

(52) *Employment and Income, Recreation and Tourism*—The proposed rule adds a new Category 1 issue, ''Employment and income,'' and combines it with the ''tourism and recreation'' portion of a current Table B–1 Category 1 issue, ''Public services: public safety, social services, and tourism and recreation.'' These issues are combined given the similar nature and to streamline the review process. The revised GEIS provides an analysis of this issue and concludes that the impacts are generic to all plants undergoing license renewal.

(53) *Tax Revenues*—The proposed rule adds a new Category 1 issue, ''Tax revenues,'' to evaluate the impacts of license renewal on tax revenues. Refurbishment activities, such as steam generator and vessel head replacement, have not had a noticeable effect on the value of nuclear plants, thus changes in tax revenues are not anticipated from future refurbishment activities. Refurbishment activities involve the one-for-one replacement of existing components and are generally not considered a taxable improvement. Also, new property tax assessments; proprietary payments in lieu of tax stipulations, settlements, and agreements; and State tax laws are continually changing the amounts paid to taxing jurisdictions by nuclear plant owners, and these occur independent of license renewal and refurbishment activities.

(54) *Community Services and Education*—The proposed rule language reclassifies two Category 2 issues, ''Public services: Public utilities'' and ''Public services, education (refurbishment)'' as Category 1 issues, and combines them with the Category 1 issue, ''Public services, education (license renewal term),'' and the ''Public safety and social service'' portion of the Category 1 issue, ''Public services: Public safety, social services, and tourism and recreation.'' The combined issue, ''Community services and education,'' is a Category 1 issue.

The four issues are combined as all public services are equally affected by changes in plant operations and refurbishment at nuclear plants. Any changes in the number of workers at a nuclear plant will affect demand for public services from local communities. Nevertheless, past environmental reviews conducted by NRC have shown that the number of workers at relicensed nuclear plants has not changed significantly because of license renewal, so impacts on community services are not anticipated from future license renewals. In addition, refurbishment activities, such as steam generator and vessel head replacement, have not required the large numbers of workers and the months of time that was conservatively analyzed in the 1996 GEIS, so significant impacts on community services are no longer anticipated. Combining the four issues also simplifies and streamlines the NRC review process. The proposed rule revises the finding column of Table B–1 accordingly.

(55) *Population and Housing*—The proposed rule language combines a new Category 1 issue, ''Population,'' and a Category 2 issue, ''Housing impacts,'' and names the combined issue, ''Population and housing.'' The combined issue is a Category 1 issue. The two issues are combined as the availability and value of housing are directly affected by changes in population and to simplify and streamline the NRC review process.

As described in the revised GEIS, the NRC has determined that the impacts of continued operations and refurbishment activities on population and housing, during the license renewal term, would be small, are not dependent on the socioeconomic setting of the nuclear plant, and are generic to all plants. The proposed rule revises the finding column of Table B–1 accordingly.

(56) *Transportation*—The proposed rule reclassifies the Category 2 issue, ''Public services, transportation,'' as a Category 1 issue and renames it ''Transportation.'' As described in the revised GEIS, the NRC has determined that the numbers of workers have not changed significantly due to license renewal, so transportation impacts are no longer anticipated from future license renewals. The proposed rule revises the finding column entry of table B–1 for this issue accordingly.

(xiii) Human Health

(57) *Radiation Exposures to the Public*—The proposed rule combines two Category 1 issues, ''Radiation exposures to the public during refurbishment'' and ''Radiation exposure to public (license renewal term)'' and names the combined issue, ''Radiation exposures to the public.'' The combined issue is a Category 1 issue. These issues are combined given the similar nature and to streamline the review process. The proposed rule revises the finding column of Table B–1 accordingly.

(58) *Radiation Exposures to Occupational Workers*—The proposed rule combines two Category 1 issues, ''Occupational radiation exposures during refurbishment'' and ''Occupational radiation exposures (license renewal term)'' and names the combined issue, ''Radiation exposures to occupational workers.'' The combined issue is a Category 1 issue. These issues are combined given their similar nature and to streamline the review process. The proposed rule revises the finding column of Table B–1 accordingly.

(59) *Human Health Impact from Chemicals*—The proposed rule adds a new Category 1 issue, ''Human health impact from chemicals,'' to evaluate the potential impacts of chemical hazards to workers and chemical releases to the environment.

The evaluation addresses the potential impact of chemicals on human health resulting from normal operations of a nuclear power plant during the license renewal term. Impacts of chemical discharges to human health are considered to be small if the discharges of chemicals to water bodies are within effluent limitations designed to ensure protection of water quality and if ongoing discharges have not resulted in adverse effects on aquatic biota.

The disposal of essentially all of the hazardous chemicals used at nuclear power plants is regulated by Resource Conservation and Recovery Act or National Pollutant Discharge Elimination System (NPDES) permits, thereby minimizing adverse impacts to the environment and on workers and the public. It is anticipated that all plants would continue to operate in compliance with all applicable permits and that no mitigation measures beyond those implemented during the current license term would be warranted as a result of license renewal.

A review of the documents, as referenced in the GEIS; operating monitoring reports; and consultations with utilities and regulatory agencies that were performed for the 1996 GEIS, indicated that the effects of the discharge of chlorine and other biocides on water quality would be of small significance for all power plants. Small quantities of biocides are readily dissipated and/or chemically altered in the body of water receiving them, so significant cumulative impacts to water quality would not be expected. Major changes in the operation of the cooling system are not expected during the license renewal term, so no change in the effects of biocide discharges on the quality of the receiving water is anticipated. Discharges of sanitary wastes and heavy metals are regulated by NPDES. Discharges that do not violate the permit limits are considered to be of small significance. The effects of minor chemical discharges and spills on water quality would be of small significance and mitigated as needed.

(60) *Microbiological Hazards to the Public (Plants with Cooling Ponds or Canals or Cooling Towers that Discharge to a River)*—The proposed rule renames ''Microbiological organisms (public health) (plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)'' as ''Microbiological hazards to the public (plants with cooling ponds or canals or cooling towers that discharge to a river);'' it remains a Category 2 issue. The proposed rule makes minor clarifying changes to the Table B–1 finding column entry for this issue.

(61) *Microbiological Hazards to Plant Workers*—The proposed rule renames ''Microbiological organisms (occupational health)'' as ''Microbiological hazards to plant workers;'' it remains a Category 1 issue. There are no changes to the Table B–1 finding column entry for this issue.

(62) *Chronic Effects of Electromagnetic Fields (EMFs)*—The proposed rule renames ''Electromagnetic fields, chronic effects'' as ''Chronic effects of electromagnetic fields (EMFs);'' it remains an uncategorized issue. The proposed rule revises the Table B–1 finding column entry for this issue.

(63) *Physical Occupational Hazards*—The proposed rule adds a new Category 1 issue, ''Physical occupational hazards,'' to evaluate the potential impact of physical occupational hazards on human health resulting from normal nuclear power plant operations during the license renewal term. The impact of physical occupational hazards on human health has been raised by members of the public as well as Federal and State agencies during the license renewal process. Occupational hazards can be minimized when workers adhere to safety standards and use appropriate protective equipment; however, fatalities and injuries from accidents can still occur. Data for occupational injuries in 2005 obtained from the U.S. Bureau of Labor Statistics indicate that the rate of fatal injuries in the utility sector is less than the rate for many sectors (*e.g.*, construction, transportation and warehousing, agriculture, forestry, fishing and hunting, wholesale trade, and mining) and that the incidence rate for nonfatal

occupational injuries and illnesses is the least for electric power generation, followed by electric power transmission control and distribution. It is expected that over the license renewal term, workers would continue to adhere to safety standards and use protective equipment, so adverse occupational impacts would be of small significance at all sites. No mitigation measures beyond those implemented during the current license term would be warranted.

(64) *Electric Shock Hazards*—The proposed rule renames ''Electromagnetic fields, acute effects (electric shock)'' as ''Electric shock hazards;'' it remains a Category 2 issue. The proposed rule revises the Table B–1 finding column entry for this issue by more accurately summarizing the discussion in the GEIS which focuses attention on the potential of electrical shock from transmission lines.

(xiv) Postulated Accidents

(65) *Design-Basis Accidents and (66) Severe Accidents*—''Design-basis accidents'' and ''Severe accidents'' remain Category 1 and 2 issues, respectively. The proposed rule makes minor clarifying changes to the Table B–1 finding column entries for these issues.

(xv) Environmental Justice

(67) *Minority and Low-Income Populations*—The proposed rule adds a new Category 2 issue, ''Minority and low-income populations,'' to evaluate the impacts of nuclear plant operations and refurbishment during the license renewal term on minority and low-income populations living in the vicinity of the plant. This issue is listed in the current Table B–1, but it was not evaluated in the 1996 GEIS. The current Table B–1 finding column entry states that ''[t]he need for and the content of an analysis of environmental justice will be addressed in plant-specific reviews.''

Executive Order 12898 (59 FR 7629; February 16, 1994) initiated the Federal government's environmental justice program. The NRC's ''Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions'' (69 FR 52040, August 24, 2004) states ''the NRC is committed to the general goals of E.O. 12898, it will strive to meet those goals through its normal and traditional NEPA review process.'' Guidance for implementing Executive Order 12898 was not available prior to the completion of the 1996 GEIS. To accomplish these goals, NRC requires the assistance of applicants in identifying minority and low-income populations and communities residing in the vicinity of the nuclear power plant and determining whether there would be any disproportionately high and adverse human health and environmental impacts on these populations from continued power plant operations and refurbishment activities during the license renewal term.

(xvi) Solid Waste Management

(68) *Low-Level Waste Storage and Disposal*—''Low-level waste storage and disposal'' remains a Category 1 issue. The proposed rule makes clarifying changes to the Table B–1 finding column entry for this issue.

(69) *Onsite Storage of Spent Nuclear Fuel*—The proposed rule renames ''On-site spent fuel'' as ''Onsite storage of spent nuclear fuel;'' it remains a Category 1 issue. The proposed rule does not change the finding column entry of Table B–1 for this issue.

(70) *Offsite Radiological Impacts of Spent Nuclear Fuel and High-Level Waste Disposal*—The proposed rule renames ''Offsite radiological impacts (spent fuel and high level waste disposal)'' as ''Offsite radiological impacts of spent nuclear fuel and high-level waste disposal.'' It remains a Category 1 issue. The proposed rule summarizes the lengthy discussion in the finding column of Table B–1 for this issue, and incorporates specific dose limits obtained from the recent docketing by the NRC of the application for the proposed repository at Yucca Mountain, Nevada.

(71) *Mixed-Waste Storage and Disposal*—''Mixed-waste storage and disposal'' remains a Category 1 issue. The proposed rule revises the Table B–1 finding column entry for this issue by more accurately summarizing the discussion in the GEIS.

(72) *Nonradioactive Waste Storage and Disposal*—The proposed language renames ''Nonradiological waste'' as ''Nonradiological waste storage and disposal;'' it remains a Category 1 issue. The proposed rule makes minor clarifying changes to the finding column of Table B–1 for this issue.

(xvii) Cumulative Impacts

(73) *Cumulative Impacts*—The proposed rule adds a new Category 2 issue, ''Cumulative impacts,'' to evaluate the potential cumulative impacts of license renewal. The term ''cumulative impacts'' is defined in § 51.14(b) by reference to the Council on Environmental Quality (CEQ) regulations, 40 CFR 1508.7, as ''the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.''

For the purposes of analysis, past actions are considered to be when the nuclear power plant was licensed and constructed, present actions are related to current plant operations, and future actions are those that are reasonably foreseeable through the end of plant operations including the license renewal term. The geographic area over which past, present, and future actions are assessed depends on the affected resource.

The NRC requires the assistance of applicants in identifying other past, present, and reasonably foreseeable future actions, such as the construction and operation of other power plants and other industrial and commercial facilities in the vicinity of the nuclear power plant. Therefore, this environmental impact is considered a Category 2 issue.

(xviii) Uranium Fuel Cycle

(74) *Offsite Radiological Impacts—Individual Impacts from Other than the Disposal of Spent Fuel and High-Level Waste*—''Offsite radiological impacts—individual impacts from other than the disposal of spent fuel and high-level waste'' remains a Category 1 issue. The proposed rule makes minor clarifying changes to the findings column of Table B–1 for this issue.

(75) *Offsite Radiological Impacts—Collective Impacts from Other than the Disposal of Spent Fuel and High-Level Waste*—The proposed rule renames ''Offsite radiological impacts (collective effects)'' as ''Offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste''; it remains a Category 1 issue. The proposed rule summarizes the discussion in the Table B–1 finding column entry for this issue.

(76) *Nonradiological Impacts of the Uranium Fuel Cycle*—Nonradiological impacts of the uranium fuel cycle'' remains a Category 1 issue. The proposed rule makes minor clarifying changes to the finding column of Table B–1 for this issue.

(77) *Transportation*—''Transportation'' remains a Category 1 issue. The proposed rule revises the Table B–1 finding column entry for this issue by retaining the significance level assigned to this environmental issue as applicable to the uranium fuel cycle. The specific technical discussion supporting these findings is retained in the GEIS.

(xiv) Termination of Nuclear Power Plant Operations and Decommissioning

(78) *Termination of Nuclear Power Plant Operations and Decommissioning*—The proposed rule combines one new Category 1 issue, ''Termination of nuclear power plant operations'' with six other Category 1 issues, ''Radiation doses,'' ''Waste management,'' ''Air quality,'' ''Water quality,'' ''Ecological resources,'' and ''Socioeconomic impacts,'' listed in the 1996 GEIS under the resource area, ''Decommissioning'' and names the combined issue, ''Termination of plant operations and decommissioning.'' This combined issue is a Category 1 issue.

The 1996 GEIS analysis indicates that the six decommissioning issues are expected to be small at all nuclear power plant sites. The new issue addresses the impacts from terminating nuclear power plant operations prior to plant decommissioning. Termination of nuclear power plant operations results in the cessation of activities necessary to maintain the reactor, as well as a significant reduction in plant workforce. It is assumed that termination of plant operations would not lead to the immediate decommissioning and dismantlement of the reactor or other power plant infrastructure.

These environmental issues and the termination of nuclear power plant operations issue would be combined into one Category 1 issue to simplify and streamline the NRC review process. These issues are also addressed in the ''2002 Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Regarding the Decommissioning of Nuclear Power Reactors,'' NUREG–0586, which is incorporated by reference in the revised GEIS. The proposed rule revises the findings column of Table B–1 accordingly.

VI. Section-by-Section Analysis

The following section-by-section analysis discusses the proposed modifications to the Part 51 provisions.

Proposed § 51.14(a)

The proposed rule adds to § 51.14(a) a definition for the term ''historic properties.'' The term is intended to be an overarching term that includes those historic, archaeological, and Native American traditional religious and cultural properties (districts, sites, buildings, structures, objects, artifacts) that are covered by the various Federal preservation laws, including the National Historic Preservation Act, and where applicable, the Archaeological Resources Protection Act and the Native American Graves Protection and Repatriation Act.

Proposed § 51.53(c)(2)

The NRC proposes to clarify the required contents of the license renewal environmental report which applicants must submit in accordance with § 54.21 by revising the second sentence in this subparagraph to read, ''This report must describe in detail the affected environment around the plant, the modifications directly affecting the environment or any plant effluents, and any planned refurbishment activities.''

Proposed §§ 51.53(c)(3)(ii)(A), (B), and (E)

For those applicants seeking an initial license renewal and holding either an operating license, construction permit, or combined license as of June 30, 1995, the environmental report shall include the information required in § 51.53(c)(2), but is not required to contain analyses of the environmental impacts of certain license renewal issues identified as Category 1 (generically analyzed) issues in Appendix B to Subpart A of Part 51. The environmental report must contain analyses of the environmental impacts of the proposed action, including the impacts of refurbishment activities, if any, associated with license renewal and the impacts of operation during the renewal term, for those issues identified as Category 2 (plant specific analysis required) issues in Appendix B to Subpart A of Part 51 and must include consideration of alternatives for reducing adverse impacts of Category 2 issues. In addition, the environmental report must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware. The required analyses are listed in §§ 51.53(c)(3)(ii)(A)–(P).

The proposed language for §§ 51.53(c)(3)(ii)(A), (B), and (E) consists of changes to conform to the proposed changes in Table B–1, which in turn, reflects the revised GEIS. The NRC proposes to modify these paragraphs to more accurately reflect the specific information needed in the environmental report that will help the NRC conduct the environmental review of the proposed action.

Section 51.53(c)(3)(ii)(A) is revised to incorporate the findings of the revised GEIS and to require applicants to provide information in their environmental reports regarding water availability and competing water demands and related impacts on instream (aquatic) and riparian (terrestrial) communities.

Section 51.53(c)(3)(ii)(B) is revised to replace ''heat shock'' with ''thermal changes'' to reflect the proposed changes made in the revised Table B–1 as described earlier in this document under ''(ix) Aquatic Resources,'' environmental impact issue, ''(39) Thermal Impacts on Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds).''

Section 51.53(c)(3)(ii)(E) is revised to expressly include power plant continued operations within the scope of the impacts to be assessed by license renewal applicants. The paragraph is further revised to expand the scope of the provision to include all Federal wildlife protection laws and essential fish habitat under the Magnuson-Stevens Fishery Conservation and Management Act.

Proposed § 51.53(c)(3)(ii)(I)

The NRC proposes to remove the language in § 51.53(c)(3)(ii)(I) to conform with the proposed changes made in the revised Table B–1 and to reserve the paragraph. These Category 2 issues were changed to Category 1 because significant changes in housing availability, land-use, and increased population demand attributable to the proposed project on the public water supply have not occurred at relicensed nuclear plants. Therefore, impacts to these resources are no longer anticipated from future license renewals. In addition, refurbishment activities, such as steam generator and vessel head replacement, have not required the large numbers of workers and the months of time that was conservatively analyzed in the 1996 GEIS. As such, significant impacts on public schools are no longer anticipated from future refurbishment activities. Applicants would no longer need to assess the impacts of the proposed action on housing availability, land-use, and public schools (impacts from refurbishment activities only) within the vicinity of the plant. Additionally, applicants would no longer need to assess the impact of population increases attributable to the proposed action on the public water supply.

Proposed § 51.53(c)(3)(ii)(J)

The NRC proposes to remove the language in § 51.53(c)(3)(ii)(J) to conform with the proposed changes made in the revised Table B–1 and to reserve the paragraph. This Category 2 issue, ''Public service, Transportation'' was changed to Category 1, ''Transportation,'' and remains under resource area, ''Socioeconomic'' because refurbishment activities, such as steam generator and vessel head replacement, have not required the large numbers of workers and the months of time that was conservatively analyzed in the 1996 GEIS; therefore significant transportation impacts are not anticipated from future refurbishment activities. Applicants would no longer need to assess the impact of the proposed action on local transportation during periods of license renewal refurbishment activities.

Proposed § 51.53(c)(3)(ii)(K)

The proposed language for § 51.53(c)(3)(ii)(K) deletes the phrase, ''or archaeological.'' This term is encompassed by the use of the term ''historical,'' as defined in the proposed rule language under § 51.14, ''Definitions.''

Proposed § 51.53(c)(3)(ii)(N)

The NRC proposes to add a new paragraph (c)(3)(ii)(N) in § 51.53 to conform with the proposed changes made in the revised Table B–1. A new Category 2 issue, ''Minority and low-income populations'' under resource area, ''Environmental Justice'' addresses the issue of determining the effects of nuclear plant operations and refurbishment on minority and low-income populations living in the vicinity of the plant. This issue is listed in the current Table B–1, but was not evaluated in the 1996 GEIS. The finding stated that: ''The need for and the content of an analysis of environmental justice will be addressed in plant-specific reviews.'' Guidance for implementing E.O. No. 12898, ''Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,'' (Section 1–101) (59 FR 7629) and dated February 16, 1994 was not available before the completion of the 1996 GEIS.

In August 2004, the Commission issued a policy statement on implementation of E.O. 12898: NRC's Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions (69 FR 52040). As stated therein, ''the NRC is committed to the general goals of E.O. 12898, it will strive to meet those goals through its normal and traditional NEPA review process.'' To accomplish these goals, NRC requires the assistance of applicants in identifying minority and low-income populations and communities residing in the vicinity of the nuclear power plant and determining if there would be any disproportionate and adverse human health and environmental impacts on these populations. The NRC will then assess the information provided by the applicant.

Proposed § 51.53(c)(3)(ii)(O)

The NRC proposes to add a new paragraph (c)(3)(ii)(O) in § 51.53 to conform with the proposed changes made in the revised Table B–1. A new Category 2 issue has been added to the GEIS to evaluate the potential contamination of soil and groundwater from industrial practices at nuclear plants. Industrial practices at all plants have the potential to contaminate site groundwater and soil through the use and spillage of solvents, hydrocarbons, heavy metals, or other chemicals, especially on sites with unlined wastewater lagoons and storm water lagoons. Any contamination by these substances is subject to characterization and clean-up by EPA and State remediation and monitoring programs. NRC requires the assistance of applicants to assess the impact of the industrial practices involving the use of solvents, hydrocarbons, heavy metals, or other chemicals where there is a potential for contamination of site groundwater, soil, and subsoil.

Proposed § 51.53(c)(3)(ii)(P)

The NRC proposes to add a new paragraph (c)(3)(ii)(P) in § 51.53 to conform with the proposed changes made in the revised Table B–1. A new Category 2 issue has been added to the GEIS to evaluate the potential cumulative effects of license renewal and refurbishment at nuclear plants. Cumulative impacts was not addressed in the 1996 GEIS, but is currently being evaluated by the NRC in plant-specific supplements to the GEIS. The Council on Environmental Quality (CEQ), in 40 CFR 1508.7, defines cumulative effects as ''the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.'' The NRC considers potential cumulative impacts on the environment resulting from the incremental impact of license renewal when added to other past, present, and reasonably foreseeable future actions.

The NRC requires the assistance of applicants in identifying other past, present, and reasonably foreseeable future actions, such as the construction and operation of other power plants and other industrial and commercial facilities in the vicinity of the nuclear power plant.

Proposed § 51.53(c)(3)(ii)(Q)

The NRC proposes to add a new paragraph (c)(3)(ii)(Q) in § 51.53 to conform with the proposed changes made in the revised Table B–1. A new Category 2 issue has been added to the GEIS to evaluate the potential impact of discharges of radionuclides, such as tritium, from plant systems into groundwater. The issue is relevant to license renewal because virtually all commercial nuclear power plants have spent fuel pools, liquid storage tanks, and buried piping that contain liquids with radioactive material that have a potential over time to degrade and release radioactive liquid into the groundwater. The NRC has investigated several cases where radioactive liquids have been inadvertently released into the groundwater in an uncontrolled manner. Any residual activity from these inadvertent releases of radioactive material is subject to characterization and possible remediation by the licensee in order to comply with NRC requirements. NRC requires the assistance of applicants in assessing the impact of any inadvertent releases of radioactive liquids into the groundwater.

Proposed § 51.71(c)

The proposed language for § 51.71(c) deletes the term ''entitlement'' and ''entitlements.'' These terms are not applicable in a license renewal context.

Proposed § 51.71(d)

The proposed language for § 51.71(d) consists of minor conforming word changes to clarify the readability and to include the analysis of cumulative effects. Cumulative impacts were not addressed in the 1996 GEIS, but are currently being evaluated by the NRC in plant-specific supplements to the GEIS. The NRC proposes to modify this paragraph to more accurately reflect the cumulative impacts analysis conducted for environmental reviews of the proposed action.

Proposed § 51.95(c)

The proposed language changes for § 51.95(c) is administrative in nature, and replaces the reference to the 1996 GEIS for license renewal of nuclear plants with a reference to the revised GEIS.

Proposed § 51.95(c)(4)

The proposed language for § 51.95(c)(4) consists of minor grammatical word changes to enhance the readability of the regulation.

VII. Specific Request for Comments

The NRC seeks comments on the proposed Part 51 provisions described in this document and on the regulatory analysis and the information collection aspects of this proposed rule.

The NRC also seeks voluntary information from industry about refurbishment activities and employment trends at nuclear power plants. Information on refurbishment would be used to evaluate the significance of impacts from this type of activity. Information on employment trends would be used to assess the significance of socioeconomic effects of ongoing plant operations on local economies.

Refurbishment

Table B.2 in the 1996 GEIS lists major refurbishment or replacement activities that the NRC used to estimate environmental impacts. The NRC recognizes that the refurbishment impact analysis in the 1996 GEIS may not accurately reflect industry experience performing the activities identified in Table B.2. Please provide (1) the estimated frequency for each activity (*e.g.*, annually, once in the lifetime of a power reactor, as-needed based on inspections, *etc.*), (2) the duration (in weeks), (3) the peak number of project workers in full-time equivalents (FTEs), (4) the timing of these activities (*e.g.*, during planned refueling or maintenance outages), and (5) whether the period of extended operation (*i.e.*, license renewal term) has triggered a need for these activities.

Employment Trends

Please provide data on the annual average number of permanent operations workers (in FTEs by year) after commencement of nuclear plant operations. If possible, the information should include a short non-proprietary discussion about general employment trends and include reasons for any significant changes in employment.

VIII. Guidance Documents

In addition to issuing the revised GEIS for public comment, the NRC is also issuing a revised RG 4.2, Supplement 1, Revision 1 and a revised ESRP, Supplement 1, Revision 1. Both documents are being published concurrently with these proposed amendments. Revised RG 4.2, Supplement 1, Revision 1, provides general procedures for the preparation of environmental reports, which are submitted as part of an application for the renewal of a nuclear power plant operating license in accordance with Title 10, Part 54, ''Requirements for Renewal of Operating Licenses for Nuclear Power Plants,'' of the Code of Federal Regulations (10 CFR Part 54). More specifically, this revised regulatory guide explains the criteria on how Category 2 issues are to be addressed in the environmental report, as specified in the proposed amendments to Part 51.

The revised ESRP, Supplement 1, Revision 1 provides guidance for NRC staff on how to conduct a license renewal environmental review. The ESRP parallels the format in RG 4.2, Supplement 1, Revision 1. The primary purpose of the ESRP is to ensure that these reviews focus on those environmental concerns associated with license renewal as described in Part 51. Additionally, in order to enhance public openness, the NRC committed to issuing for public comment with the proposed rule, the RG 4.2, Supplement 1, Revision 1 and ESRP, Supplement 1, Revision 1.

IX. Agreement State Compatibility

Under the ''Policy Statement on Adequacy and Compatibility of Agreement States Programs,'' approved by the Commission on June 20, 1997, and published in the **Federal Register** (62 FR 46517; September 3, 1997), this rule is classified as compatibility category ''NRC.'' Agreement State Compatibility is not required for Category ''NRC'' regulations. The NRC program elements in this category are those that relate directly to areas of regulation reserved to the NRC by the Atomic Energy Act or the provisions of 10 CFR. Although an Agreement State may not adopt program elements reserved to NRC, it may wish to inform its licensees of certain requirements via a mechanism that is consistent with the particular State's administrative procedure laws, but does not confer regulatory authority on the State.

X. Availability of Documents

The NRC is making the documents identified below available to interested persons through one or more of the following methods, as indicated.

Public Document Room (PDR). The NRC Public Document Room is located at 11555 Rockville Pike, Rockville, Maryland 20852.

Regulations.gov (Web). These documents may be viewed and downloaded electronically through the Federal eRulemaking Portal *http://www.regulations.gov* Docket number NRC–2008–0608.

NRC's Electronic Reading Room (ERR). The NRC's public electronic reading room is located at *http://www.nrc.gov/reading-rm.html.*

Document	PDR	Regs.gov	Web	ERR (ADAMS)	NRC staff
Draft NUREG–1437, Vols. 1 and 2, Revision 1—''Generic Environmental Impact Statement for License Renewal of Nuclear Plants''	X	X	X	ML090220654	X
Draft Regulatory Guide (RG) 4.2 Supplement 1, Revision 1—''Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications''	X	X	X	ML091620409	X
Draft NUREG–1555, Supplement 1, Revision 1—''Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal''	X	X	X	ML090230497	X
Draft Regulatory Analysis for RIN 3150–AI42 Proposed Rulemaking Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses	X	X	X	ML083460087	X
Draft OMB Supporting Statement for RIN 3150–AI42 Proposed Rulemaking Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses	X	X	X	ML090260568	X
Summary of Public Scoping Meeting to Discuss Update to the Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Atlanta, GA	X	X	X	ML032170942	X
Summary of Public Scoping Meeting to Discuss Update to the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG–1437), Oak Lawn, IL	X	X	X	ML032260339	X
Summary of Public Scoping Meeting To Discuss Update to the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG–1437), Anaheim, CA	X	X	X	ML032260715	X

Document	PDR	Regs.gov	Web	ERR (ADAMS)	NRC staff
Summary of Public Scoping Meeting to Discuss Update to the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG–1437), Boston, MA	X	X	X	ML032170934	X
Liquid Radiation Release Lessons Learned Task	X	X	X	ML062650312	X
NUREG/CP–0108, "Proceedings of the Public Workshop on Nuclear Power Plant License Renewal" (April 1990)	X	....	....	....	X
NUREG–1411, "Response to Public Comments Resulting from the Public Workshop on Nuclear Power Plant License Renewal" (July 1990)	X	....	....	....	X
"Addressing the Concerns of States and Others Regarding the Role of Need for Generating Capacity, Alternate Energy Sources, Utility Costs, and Cost-Benefit Analysis in NRC Environmental Reviews for Relicensing Nuclear Power Plants: An NRC Staff Discussion Paper"	X	....	....	....	X
NUREG–0586, "2002 Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Regarding the Decommissioning of Nuclear Power Reactors"	X	....	....	....	X

XI. Plain Language

The Presidential memorandum dated June 1, 1998, entitled "Plain Language in Government Writing" directed that the Government's writing be in clear and accessible language. This memorandum was published on June 10, 1998 (63 FR 31883). The NRC requests comments on the proposed rule specifically with respect to the clarity and effectiveness of the language used. Comments should be sent to the NRC as explained in the **ADDRESSES** heading of this document.

XII. Voluntary Consensus Standards

The National Technology Transfer and Advancement Act of 1995, Public Law 104–113, requires that Federal agencies use technical standards that are developed or adopted by voluntary consensus standards bodies unless using such a standard is inconsistent with applicable law or is otherwise impractical. The NRC is not aware of any voluntary consensus standard that could be used instead of the proposed Government standards. The NRC will consider using a voluntary consensus standard if an appropriate standard is identified.

XIII. Finding of No Significant Environmental Impact

The NRC has determined that this proposed regulation is the type of action described in categorical exclusion § 51.22(c)(3). Therefore, neither an environmental impact statement nor an environmental assessment has been prepared for this proposed regulation. This action is procedural in nature in that it pertains to the type of environmental information to be reviewed.

XIV. Paperwork Reduction Act Statement

This proposed rule would contain new or amended information collection requirements that are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501, *et seq*). This proposed rule has been submitted to the Office of Management and Budget (OMB) for review and approval of the information collection requirements.

Type of submission, new or revision: Revision.

The title of the information collection: 10 CFR Part 51 Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, Proposed Rule.

The form number if applicable: Not applicable.

How often the collection is required: Once per license renewal.

Who will be required or asked to report: Applicants for license renewal.

An estimate of the number of annual responses: Six.

The estimated number of annual respondents: Six.

An estimate of the total number of hours needed annually to complete the requirement or request (net one-time reporting): 1,944.00 hours

Abstract: 10 CFR Part 51 specifies information to be provided by applicants and licensees so that the NRC can make determinations necessary to adhere to the policies, regulations, and public laws of the United States, which are to be interpreted and administered in accordance with the policies set forth in the National Environmental Policy Act of 1969, as amended.

The NRC is seeking public comment on the potential impact of the information collections contained in this proposed rule and on the following issues:

1. Is the proposed information collection necessary for the NRC to properly perform its functions? Does the information have practical utility?
2. Is the burden estimate accurate?
3. Is there a way to enhance the quality, utility, and clarity of the information to be collected?
4. How can the burden of the information collection be minimized, including the use of automated collection techniques or other forms of information technology?

A copy of the OMB clearance package may be viewed free of charge at the NRC Public Document Room, One White Flint North, 11555 Rockville Pike, Room O–1F21, Rockville, MD 20852. The OMB clearance package and rule are available at the NRC worldwide Web site: *http://www.nrc.gov/public-involve/doc-comment/omb/index.htm* for 60 days after the signature date of this notice.

Send comments on any aspect of these proposed information collections, including suggestions for reducing the burden and on the above issues, by October 14, 2009. Comments received after this date will be considered if it is practical to do so, but assurance of consideration cannot be given to comments received after this date. Comments submitted in writing or in electronic form will be made available for public inspection. Because your comments will not be edited to remove any identifying or contact information, the NRC cautions you against including any information in your submission that you do not want to be publicly disclosed. Comments submitted should reference Docket No. NRC–2008–0608. Comments can be submitted in electronic form via the Federal e-Rulemaking Portal at *http://www.regulations.gov* by search for Docket No. NRC–2008–0608. Comments can be mailed to NRC Clearance Officer, Tremaine Donnell (T–5F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001. Questions about the information collection requirements may be directed to the NRC Clearance Officer, Tremaine Donnell (T–5 F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001, by telephone at (301) 415–5258, or by e-mail to *INFOCOLLECTS.Resource@nrc.gov*. Comments can be mailed to the Desk Officer, Office of Information and Regulatory Affairs, NEOB–10202, (3150–0021), Office of Management and Budget, Washington, DC 20503, or by e-mail to *Christine_J._Kyma@omb.eop.gov* or by telephone at (202) 395–4638.

XV. Regulatory Analysis

The Commission has prepared a regulatory analysis on this proposed regulation. The analysis examines the costs and benefits of the alternatives considered by the NRC. The two alternatives considered (a) No Action—no change to applicable license renewal portions of Part 51 regulations, including Table B–1, which would require applicants seeking license renewal to comply with the existing provisions; or (b) review and update the environmental impact issues and findings and amend applicable license renewal portions of Part 51 and Table B–1. The conclusions of the regulatory analysis show substantial cost savings of alternative (b) over alternative (a).

The NRC requests public comments on this regulatory analysis. Information on availability of the regulatory analysis is provided in Section X of this document. Comments on the regulatory analysis may be submitted to the NRC as indicated under the **ADDRESSES** heading of this document.

XVI. Regulatory Flexibility Act Certification

Under the Regulatory Flexibility Act (5 U.S.C. 605(b)), the Commission certifies that this rule would not, if promulgated, have a significant economic impact on a substantial number of small entities. This proposed rule would only affect nuclear power plant licensees filing license renewal applications. The companies that own these plants do not fall within the scope of the definition of ''small entities'' set forth in the Regulatory Flexibility Act or the size standards established by the NRC (§ 2.810).

XVII. Backfit Analysis

The NRC has determined that the requirements in this proposed rule do not constitute backfitting as defined in § 50.109(a)(1). Therefore, a backfit analysis has not been prepared for this proposed rule.

List of Subjects in 10 CFR Part 51

Administrative practice and procedure, Environmental impact statement, Nuclear materials, Nuclear power plants and reactors, Reporting and recordkeeping requirements.

For the reasons set out in the preamble and under the authority of the Atomic Energy Act of 1954, as amended; the Energy Reorganization Act of 1974, as amended; and 5 U.S.C. 553; the NRC is proposing to adopt the following amendments to 10 CFR Part 51.

PART 51—ENVIRONMENTAL PROTECTION REGULATIONS FOR DOMESTIC LICENSING AND RELATED REGULTORY FUNCTIONS

1. The authority citation for Part 51 continues to read as follows:

Authority: Sec. 161, 68 Stat. 948, as amended, sec. 1701, 106 Stat. 2951, 2952, 2953 (42 U.S.C. 2201, 2297f); secs. 201, as amended, 202, 88 Stat. 1242, as amended, 1244 (42 U.S.C. 5841, 5842); sec. 1704, 112 Stat. 2750 (44 U.S.C. 3504 note). Subpart A also issued under National Environmental Policy Act of 1969, secs. 102, 104, 105, 83 Stat. 853–854, as amended (42 U.S.C. 4332, 4334, 4335); and Pub. L. 95–604, Title II, 92 Stat. 3033–3041; and sec. 193, Pub. L. 101–575, 104 Stat. 2835 (42 U.S.C. 2243). Sections 51.20, 51.30, 51.60, 51.80, and 51.97 also issued under secs. 135, 141, Pub. L. 97–425, 96 Stat. 2232, 2241, and sec. 148, Pub. L. 100–203, 101 Stat. 1330–223 (42 U.S.C. 10155, 10161, 10168). Section 51.22 also issued under sec. 274, 73 Stat. 688, as amended by 92 Stat. 3036–3038 (42 U.S.C. 2021) and under Nuclear Waste Policy Act of 1982, sec. 121, 96 Stat. 2228 (42 U.S.C. 10141). Sections 51.43, 51.67, and 51.109 also issued under Nuclear Waste Policy Act of 1982, sec. 114(f), 96 Stat. 2216, as amended (42 U.S.C. 10134(f)).

2. Section 51.14(a) is amended by adding the term *Historic properties* in alphabetical order to read as follows:

§ 51.14 Definitions.

(a) * * *

Historic properties means any prehistoric or historic districts, sites, buildings, structures, or objects included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretary of the Interior. This term includes properties of traditional religious and cultural importance to an Indian Tribe or Native Hawaiian organization and that meet the National Register criteria. The term also includes archaeological resources, such as artifacts, records, and remains, that are related to and located within such prehistoric or historic districts, sites, buildings, or structures.

* * * * *

3. Amend § 51.53 to revise the second sentence of paragraph (c)(2), revise the first sentence of paragraph (c)(3)(ii)(A), revise the second sentence of paragraph (c)(3)(ii)(B), revise paragraph (c)(3)(ii)(E), to remove and reserve paragraphs (c)(3)(ii)(I) and (J), to revise paragraph (c)(3)(ii)(K) and to add paragraphs (c)(3)(ii)(N), (O), (P), and (Q) to read as follows:

§ 51.53 Postconstruction environmental reports.

* * * * *

(c) * * *

(2) * * * This report must describe in detail the affected environment around the plant, the modifications directly affecting the environment or any plant effluents, and any planned refurbishment activities. * * *

(3) * * *

(ii) * * *

(A) If the applicant's plant utilizes cooling towers or cooling ponds and withdraws make-up water from a river whose annual flow rate is less than 3.15×10^{12} ft^3/year (9×10^{10}m^3/year), an assessment of the impact of the proposed action on water availability and competing water demands, the flow of the river, and related impacts on instream (aquatic) and riparian (terrestrial) ecological communities must be provided. * * *

(B) * * * If the applicant can not provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from thermal changes and impingement and entrainment.

* * * * *

(E) All license renewal applicants shall assess the impact of refurbishment, continued operations, and other license-renewal-related construction activities on important plant and animal habitats. Additionally, the applicant shall assess the impact of the proposed action on threatened or endangered species in accordance with Federal laws protecting wildlife, including but not limited to the Endangered Species Act, and essential fish habitat in accordance with the Magnuson-Stevens Fishery Conservation and Management Act.

* * * * *

(I) [Reserved]

(J) [Reserved]

(K) All applicants shall assess whether any historic properties will be affected by the proposed project.

* * * * *

(N) Applicants shall provide information on the general demographic composition of minority- and low-income populations and communities (by race and ethnicity) residing in the immediate vicinity of the plant that could be affected by the renewal of the plant's operating license, including any planned refurbishment activities, and ongoing and future plant operations.

(O) If the applicant's plant conducts industrial practices involving the use of solvents, hydrocarbons, heavy metals, or other chemicals and has unlined wastewater lagoons, the applicant shall assess the potential for contamination of site groundwater, soil, and subsoil. The applicant shall provide an assessment of dissolved chemical and suspended sediment discharge to the plant's wastewater lagoons in addition to National Pollutant Discharge Elimination System (NPDES) compliance data collected for submittal to the U.S. Environmental Protection Agency (EPA) or designated State agency. A summary of existing reports describing site groundwater and soil contamination should also be included.

(P) Applicants shall provide information about past, present, and reasonably foreseeable future actions occurring in the vicinity of the nuclear plant that may result in a cumulative effect. For example, the applicant should include information about the construction and operation of other power plants and other industrial and commercial facilities in the vicinity of the nuclear plant.

(Q) An applicant shall assess the impact of any inadvertent releases of radionuclides into groundwater. The applicant shall include in its assessment a description of any groundwater protection program for the site, including a description of any monitoring wells, leak detection equipment, or procedures for the surveillance of accessible piping and components containing radioactive materials. The assessment shall also include a description of any past inadvertent releases, including information on the source of the release, the location of the release within the plant site, the types of radionuclides involved, including the quantities, forms, and concentrations of such radionuclides, and the projected impact to the environment during the license renewal term, including the projected transport pathways, concentrations of the radionuclides, and potential receptors (*e.g.*, aquifers, rivers, lakes, ponds, ocean).

* * * * *

4. Amend § 51.71 to revise paragraphs (c) and (d) to read as follows:

§ 51.71 Draft environmental impact statement—contents.

* * * * *

(c) *Status of compliance.* The draft environmental impact statement will list all Federal permits, licenses, and approvals which must be obtained in implementing the proposed action and will describe the status of compliance with those requirements. If it is uncertain whether a Federal permit, license, or approval is necessary, the draft environmental impact statement will so indicate.

(d) *Analysis.* Unless excepted in this paragraph or § 51.75, the draft environmental impact statement will include a preliminary analysis that considers and weighs the environmental effects, including any cumulative effects, of the proposed action; the environmental impacts of alternatives to the proposed action; and alternatives available for reducing or avoiding adverse environmental effects. Additionally, the draft environmental impact statement will include a consideration of the economic, technical, and other benefits and costs of the proposed action and alternatives. The draft environmental impact statement will indicate what other interests and considerations of Federal policy, including factors not related to environmental quality, if applicable, are relevant to the consideration of environmental effects of the proposed action identified under paragraph (a) of this section. The draft supplemental environmental impact statement prepared at the license renewal stage under § 51.95(c) need not discuss the economic or technical benefits and costs of either the proposed action or alternatives except if benefits and costs are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation. In addition, the supplemental environmental impact statement prepared at the license renewal stage need not discuss other issues not related to the environmental effects of the proposed action and associated alternatives. The draft supplemental environmental impact statement for license renewal prepared under § 51.95(c) will rely on conclusions as amplified by the supporting information in the GEIS for issues designated as Category 1 in appendix B to subpart A of this part. The draft supplemental environmental impact statement must contain an analysis of those issues identified as Category 2 in appendix B to subpart A of this part that are open for the proposed action. The analysis for all draft environmental impact statements will, to the fullest extent practicable, quantify the various factors considered. To the extent that there are important qualitative considerations or factors that cannot be quantified, these considerations or factors will be discussed in qualitative terms. Consideration will be given to compliance with environmental quality standards and requirements that have been imposed by Federal, State, regional, and local agencies having responsibility for environmental protection, including applicable zoning and land-use regulations and water pollution limitations or requirements issued or imposed under the Federal Water Pollution Control Act. The environmental impact of the proposed action will be considered in the analysis with respect to matters covered by environmental quality standards and requirements irrespective of whether a certification or license from the appropriate authority has been obtained.[3] While satisfaction of Commission standards and criteria pertaining to radiological effects will be necessary to meet the licensing requirements of the Atomic Energy Act, the analysis will, for the purposes of NEPA, consider the radiological effects of the proposed action and alternatives.

* * * * *

5. Amend § 51.95 to revise the introductory text of paragraph (c), and the second sentence of paragraph (c)(4) to read as follows:

§ 51.95 Postconstruction environmental impact statements.

* * * * *

(c) *Operating license renewal stage.* In connection with the renewal of an operating license or combined license

[3] Compliance with the environmental quality standards and requirements of the Federal Water Pollution Control Act (imposed by EPA or designated permitting states) is not a substitute for, and does not negate the requirement for NRC to weigh all environmental effects of the proposed action, including the degradation, if any, of water quality, and to consider alternatives to the proposed action that are available for reducing adverse effects. Where an environmental assessment of aquatic impact from plant discharges is available from the permitting authority, the NRC will consider the assessment in its determination of the magnitude of environmental impacts for striking an overall cost-benefit balance at the construction permit and operating license and early site permit and combined license stages, and in its determination of whether the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decision-makers would be unreasonable at the license renewal stage. When no such assessment of aquatic impacts is available from the permitting authority, NRC will establish on its own, or in conjunction with the permitting authority and other agencies having relevant expertise, the magnitude of potential impacts for striking an overall cost-benefit balance for the facility at the construction permit and operating license and early site permit and combined license stages, and in its determination of whether the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decision-makers would be unreasonable at the license renewal stage.

for a nuclear power plant under parts 52 or 54 of this chapter, the Commission shall prepare an environmental impact statement, which is a supplement to the Commission's NUREG–1437, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants'' [(Month 20XX)], which is available in the NRC Public Document Room, 11555 Rockville Pike, Rockville, Maryland.

* * * * *

(4) * * * In order to make recommendations and reach a final decision on the proposed action, the NRC staff, adjudicatory officers, and Commission shall integrate the conclusions in the generic environmental impact statement for issues designated Category 1 (with the exception of offsite radiological impacts for collective effects and the disposal of spent fuel and high level waste) with information developed for those open Category 2 issues applicable to the plant under § 51.53(c)(3)(ii), and any new and significant information. * * *

* * * * *

6. In Appendix B to Subpart A of Part 51, Table B–1 is revised to read as follows:

Appendix B to Subpart A—Environmental Effect of Renewing the Operating License of a Nuclear Power Plant

* * * * *

TABLE B–1—SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS [1]

Issue	Category [2]	Finding [3]
Land Use		
Onsite land use	1	SMALL. Changes in onsite land use from continued operations and refurbishment associated with the license renewal term would be a small fraction of any nuclear power plant site and would involve only land that is controlled by the licensee.
Offsite land use	1	SMALL. Offsite land use would not be affected from continued operations and refurbishment associated with the license renewal term.
Offsite land use in transmission line rights-of-way (ROWs).	1	SMALL. Use of transmission line ROWs from continued operations and refurbishment associated with the license renewal term would continue with no change in land use restrictions.
Visual Resources		
Aesthetic impacts	1	SMALL. No important changes to the visual appearance of plant structures or transmission lines are expected from continued operations and refurbishment associated with the license renewal term.
Air Quality		
Air quality (non-attainment and maintenance areas).	2	SMALL, MODERATE, or LARGE. Air quality impacts of continued operations and refurbishment activities associated with the license renewal term are expected to be small. However, emissions during these activities could be a cause for concern at locations in or near air quality nonattainment or maintenance areas. The significance of the impact cannot be determined without considering the compliance status of each site and the activities that could occur. These impacts would be short-lived and cease after projects were completed. Emissions from testing emergency diesel generators and fire pumps and from routine operations of boilers used for space heating would not be a concern, even for those plants located in or adjacent to nonattainment areas. Although particulate emissions from cooling towers may be a concern for a very limited number of plants located in States that regulate such emissions, the impacts in even these worst-case situations have been small.
Air quality effects of transmission lines	1	SMALL. Production of ozone and oxides of nitrogen is insignificant and does not contribute measurably to ambient levels of these gases.
Noise		
Noise impacts	1	SMALL. Noise levels would remain below regulatory guidelines for offsite receptors during continued operations and refurbishment associated with the license renewal term.
Geology and Soils		
Impacts of nuclear plants on geology and soils.	1	SMALL. Impacts on geology and soils would be small at all nuclear plants if best management practices were employed to reduce erosion associated with continued operations and refurbishment.
Surface Water		
Surface-water use and quality	1	SMALL. Impacts are expected to be negligible if best management practices are employed to control soil erosion and spills. Water use associated with continued operation and refurbishment projects for license renewal would not increase significantly or would be reduced if a plant outage is necessary to accomplish the action.
Altered current patterns at intake and discharge structures.	1	SMALL. Altered current patterns would be limited to the area in the vicinity of the intake and discharge structures. These impacts have been small at operating nuclear power plants.

TABLE B–1—SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS [1]—Continued

Issue	Category [2]	Finding [3]
Altered salinity gradients	1	SMALL. Effects on salinity gradients would be limited to the area in the vicinity of the intake and discharge structures. These impacts have been small at operating nuclear power plants.
Altered thermal stratification of lakes	1	SMALL. Effects on thermal stratification would be limited to the area in the vicinity of the intake and discharge structures. These impacts have been small at operating nuclear power plants.
Scouring caused by discharged cooling water.	1	SMALL. Scouring effects would be limited to the area in the vicinity of the intake and discharge structures. These impacts have been small at operating nuclear power plants.
Discharge of metals in cooling system effluent.	1	SMALL. Discharges of metals have not been found to be a problem at operating nuclear power plants with cooling-tower-based heat dissipation systems and have been satisfactorily mitigated at other plants. Discharges are monitored as part of the National Pollutant Discharge Elimination System (NPDES) permit process.
Discharge of biocides, sanitary wastes, and minor chemical spills.	1	SMALL. The effects of these discharges are regulated by State and Federal environmental agencies. Discharges are monitored as part of the NPDES permit process. These impacts have been small at operating nuclear power plants.
Water use conflicts (plants with once-through cooling systems).	1	SMALL. These conflicts have not been found to be a problem at operating nuclear power plants with once-through heat dissipation systems.
Water use conflicts (plants with cooling ponds or cooling towers using make-up water from a river with low flow).	2	SMALL or MODERATE. Impacts could be of small or moderate significance, depending on makeup water requirements, water availability, and competing water demands.
Effects of dredging on water quality	1	SMALL. Dredging to remove accumulated sediments in the vicinity of intake and discharge structures and to maintain barge shipping has not been found to be a problem for surface water quality. Dredging is performed under permit from the U.S. Army Corps of Engineers.
Temperature effects on sediment transport capacity.	1	SMALL. These effects have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Groundwater		
Groundwater use and quality	1	SMALL. Extensive dewatering is not anticipated from continued operations and refurbishment activities associated with the license renewal term. The application of best management practices for handling any materials produced or used during activities would reduce impacts.
Groundwater use conflicts (plants that withdraw less than 100 gallons per minute [gpm]).	1	SMALL. Plants that withdraw less than 100 gpm are not expected to cause any groundwater use conflicts.
Groundwater use conflicts (plants that withdraw more than 100 gpm including those using Ranney wells).	2	SMALL, MODERATE, or LARGE. Plants that withdraw more than 100 gpm could cause groundwater use conflicts with nearby groundwater users.
Groundwater use conflicts (plants with closed-cycle cooling systems that withdraw makeup water from a river).	2	SMALL, MODERATE, or LARGE. Water use conflicts could result from water withdrawals from rivers during low-flow conditions, which may affect aquifer recharge. The significance of impacts would depend on makeup water requirements, water availability, and competing water demands.
Groundwater quality degradation resulting from water withdrawals.	1	SMALL. Groundwater withdrawals at operating nuclear power plants would not contribute significantly to groundwater quality degradation.
Groundwater quality degradation (plants with cooling ponds in salt marshes).	1	SMALL. Sites with closed-cycle cooling ponds could degrade groundwater quality; however, because groundwater in salt marshes is brackish, this is not a concern for plants located in salt marshes.
Groundwater quality degradation (plants with cooling ponds at inland sites).	2	SMALL, MODERATE, or LARGE. Sites with closed-cycle cooling ponds could degrade groundwater quality. For plants located inland, the quality of the groundwater in the vicinity of the ponds could be affected. The significance of the impact would depend on cooling pond water quality, site hydrogeologic conditions (including the interaction of surface water and groundwater), and the location, depth, and pump rate of water wells.
Groundwater and soil contamination	2	SMALL or MODERATE. Industrial practices involving the use of solvents, hydrocarbons, heavy metals, or other chemicals and unlined wastewater lagoons have the potential to contaminate site groundwater, soil, and subsoil. Contamination is subject to State and Environmental Protection Agency regulated cleanup and monitoring programs.
Radionuclides released to groundwater	2	SMALL or MODERATE. Underground system leaks of process water have been discovered in recent years at several plants. Groundwater protection programs have been established at all operating nuclear power plants.

TABLE B–1—SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS [1]—Continued

Issue	Category [2]	Finding [3]
Terrestrial Resources		
Impacts of continued plant operations on terrestrial ecosystems.	2	SMALL, MODERATE, or LARGE. Continued operations, refurbishment, and maintenance activities are expected to keep terrestrial communities in their current condition. Application of best management practices would reduce the potential for impacts. The magnitude of impacts would depend on the nature of the activity, the status of the resources that could be affected, and the effectiveness of mitigation.
Exposure of terrestrial organisms to radionuclides.	1	SMALL. Doses to terrestrial organisms are expected to be well below exposure guidelines developed to protect these organisms.
Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds).	1	SMALL. No adverse effects to terrestrial plants or animals have been reported as a result of increased water temperatures, fogging, humidity, or reduced habitat quality. Due to the low concentrations of contaminants in cooling system effluents, uptake and accumulation of contaminants in the tissues of wildlife exposed to the contaminated water or aquatic food sources are not expected to be significant issues.
Cooling tower impacts on vegetation (plants with cooling towers).	1	SMALL. Impacts from salt drift, icing, fogging, or increased humidity associated with cooling tower operation have the potential to affect adjacent vegetation, but these impacts have been small at operating nuclear power plants and are not expected to change over the license renewal term.
Bird collisions with cooling towers and transmission lines.	1	SMALL. Bird collisions with cooling towers and transmission lines occur at rates that are unlikely to affect local or migratory populations.
Water use conflicts with terrestrial resources (plants with cooling ponds or cooling towers using make-up water from a river with low flow).	2	SMALL or MODERATE. Impacts on terrestrial resources in riparian communities affected by water use conflicts could be of moderate significance in some situations.
Transmission line ROW management impacts on terrestrial resources.	1	SMALL. Continued ROW management during the license renewal term is expected to keep terrestrial communities in their current condition. Application of best management practices would reduce the potential for impacts.
Electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock).	1	SMALL. No significant impacts of electromagnetic fields on terrestrial flora and fauna have been identified. Such effects are not expected to be a problem during the license renewal term.
Aquatic Resources		
Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds).	2	SMALL, MODERATE, or LARGE. The impacts of impingement and entrainment are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems, depending on cooling system withdrawal rates and volumes and the aquatic resources at the site.
Impingement and entrainment of aquatic organisms (plants with cooling towers).	1	SMALL. Impingement and entrainment rates are lower at plants that use closed-cycle cooling with cooling towers because the rates and volumes of water withdrawal needed for makeup are minimized.
Thermal impacts on aquatic organisms (plants with once-through cooling systems or cooling ponds).	2	SMALL, MODERATE, or LARGE. Most of the effects associated with thermal discharges are localized and are not expected to affect overall stability of populations or resources. The magnitude of impacts, however, would depend on site-specific thermal plume characteristics and the nature of aquatic resources in the area.
Thermal impacts on aquatic organisms (plants with cooling towers).	1	SMALL. Thermal effects associated with plants that use cooling towers are small because of the reduced amount of heated discharge.
Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication.	1	SMALL. Gas supersaturation was a concern at a small number of operating nuclear power plants with once-through cooling systems but has been satisfactorily mitigated. Low dissolved oxygen was a concern at one nuclear power plant with a once-through cooling system but has been effectively mitigated. Eutrophication (nutrient loading) and resulting effects on chemical and biological oxygen demands have not been found to be a problem at operating nuclear power plants.
Effects of non-radiological contaminants on aquatic organisms.	1	SMALL. Best management practices and discharge limitations of NPDES permits are expected to minimize the potential for impacts to aquatic resources. Accumulation of metal contaminants has been a concern at a few nuclear power plants but has been satisfactorily mitigated by replacing copper alloy condenser tubes with those of another metal.
Exposure of aquatic organisms to radionuclides.	1	SMALL. Doses to aquatic organisms are expected to be well below exposure guidelines developed to protect these aquatic organisms.
Effects of dredging on aquatic organisms	1	SMALL. Effects of dredging on aquatic resources tend to be of short duration (years or less) and localized. Dredging requires permits from the U.S. Army Corps of Engineers, State environmental agencies, and other regulatory agencies.
Water use conflicts with aquatic resources (plants with cooling ponds or cooling towers using make-up water from a river with low flow).	2	SMALL or MODERATE. Impacts on aquatic resources in instream communities affected by water use conflicts could be of moderate significance in some situations.
Refurbishment impacts on aquatic resources.	1	SMALL. Refurbishment impacts with appropriate mitigation are not expected to change aquatic communities from their current condition.

TABLE B–1—SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS [1]—Continued

Issue	Category [2]	Finding [3]
Impacts of transmission line ROW management on aquatic resources.	1	SMALL. Application of best management practices to ROW near aquatic systems would reduce the potential for impacts.
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses.	1	SMALL. These types of losses have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Stimulation of aquatic nuisance species (*e.g.*, shipworms).	1	SMALL. Stimulation of nuisance organisms has been satisfactorily mitigated at the single nuclear power plant with a once-through cooling system where previously it was a problem. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.
Threatened, Endangered, and Protected Species and Essential Fish Habitat		
Threatened, endangered, and protected species and essential fish habitat.	2	SMALL, MODERATE, or LARGE. The magnitude of impacts on threatened, endangered, and protected species and essential fish habitat would depend on the occurrence of listed species and habitats and the effects of power plant systems on them. Consultation with appropriate agencies would be needed to determine whether special status species or habitats are present and whether they would be adversely affected by activities associated with license renewal.
Historic and Cultural Resources		
Historic and cultural resources	2	SMALL, MODERATE, or LARGE. Continued operations and refurbishment associated with the license renewal term are expected to have no more than small impacts on historic and cultural resources located onsite and in the transmission line ROW because most impacts could be mitigated by avoiding those resources. The National Historic Preservation Act (NHPA) requires the Federal agency to consult with the State Historic Preservation Officer (SHPO) and appropriate Native American tribes to determine the potential impacts and mitigation. *See* § 51.14(a).
Socioeconomics		
Employment and income, recreation and tourism.	1	SMALL. Although most nuclear plants have large numbers of employees with higher than average wages and salaries, employment and income impacts from continued operations and refurbishment are expected to be small. Nuclear plant operations, employee spending, power plant expenditures, and tax payments have an effect on local economies. Changes in plant operations, employment and expenditures would have a greater effect on rural economies than on semi-urban economies.
Tax revenues	1	SMALL. Nuclear plants provide tax revenue to local jurisdictions in the form of property tax payments, payments in lieu of tax (PILOT), or tax payments on energy production. The amount of tax revenue paid during the license renewal term from continued operations and refurbishment is not expected to change, since the assessed value of the power plant, payments on energy production and PILOT payments are also not expected to change.
Community services and education	1	SMALL. Changes to local community and educational services would be small from continued operations and refurbishment associated with the license renewal term. With no increase in employment, value of the power plant, payments on energy production, and PILOT payments expected during the license renewal term, community and educational services would not be affected by continued power plant operations. Changes in employment and tax payments would have a greater effect on jurisdictions receiving a large portion of annual revenues from the power plant than on jurisdictions receiving the majority of their revenues from other sources.
Population and housing	1	SMALL. Changes to regional population and housing availability and value would be small from continued operations and refurbishment associated with the license renewal term. With no increase in employment expected during the license renewal term, population and housing availability and values would not be affected by continued power plant operations. Changes in housing availability and value would have a greater effect on sparsely populated areas than areas with higher density populations.
Transportation	1	SMALL. Changes to traffic volumes would be small from continued operations and refurbishment activities associated with the license renewal term. Changes in employment would have a greater effect on rural areas, with less developed local and regional networks. Impacts would be less noticeable in semi-urban areas depending on the quality and extent of local access roads and the timing of plant shift changes when compared to typical local usage.
Human Health		
Radiation exposures to the public	1	SMALL. Radiation doses to the public from continued operations and refurbishment associated with the license renewal term are expected to continue at current levels, and would be well below regulatory limits.

TABLE B–1—SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS [1]—Continued

Issue	Category [2]	Finding [3]
Radiation exposures to occupational workers.	1	SMALL. Occupational doses from continued operations and refurbishment associated with the license renewal term are expected to be within the range of doses experienced during the current license term, and would continue to be well below regulatory limits.
Human health impact from chemicals	1	SMALL. Chemical hazards to workers would be minimized by observing good industrial hygiene practices. Chemical releases to the environment and the potential for impacts to the public are minimized by adherence to discharge limitations of NPDES permits.
Microbiological hazards to the public (plants with cooling ponds or canals or cooling towers that discharge to a river).	2	SMALL, MODERATE, or LARGE. These organisms are not expected to be a problem at most operating plants except possibly at plants using cooling ponds, lakes, or canals that discharge to rivers. Impacts would depend on site-specific characteristics.
Microbiological hazards to plant workers	1	SMALL. Occupational health impacts are expected to be controlled by continued application of accepted industrial hygiene practices to minimize worker exposures.
Chronic effects of electromagnetic fields (EMFs) [5].	N/A [4]	Uncertain impact. Studies of 60–Hz EMFs have not uncovered consistent evidence linking harmful effects with field exposures. EMFs are unlike other agents that have a toxic effect (*e.g.*, toxic chemicals and ionizing radiation) in that dramatic acute effects cannot be forced and longer-term effects, if real, are subtle. Because the state of the science is currently inadequate, no generic conclusion on human health impacts is possible.
Physical occupational hazards	1	SMALL. Occupational safety and health hazards are generic to all types of electrical generating stations, including nuclear power plants, and is of small significance if the workers adhere to safety standards and use protective equipment.
Electric shock hazards	2	SMALL, MODERATE, or LARGE. Electrical shock potential is of small significance for transmission lines that are operated in adherence with the National Electrical Safety Code (NESC). Without a review of each nuclear plant transmission line conformance with NESC criteria, it is not possible to determine the significance of the electrical shock potential.
Postulated Accidents		
Design-basis accidents	1	SMALL. The NRC staff has concluded that the environmental impacts of design-basis accidents are of small significance for all plants.
Severe accidents	2	SMALL. The probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives.
Environmental Justice		
Minority and low-income populations	2	SMALL or MODERATE. Impacts to minority and low-income populations and subsistence consumption will be addressed in plant-specific reviews. *See* NRC Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions (69 FR 52040).
Solid Waste Management		
Low-level waste storage and disposal	1	SMALL. The comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts to the environment would remain small during the term of a renewed license.
Onsite storage of spent nuclear fuel	1	SMALL. The expected increase in the volume of spent fuel from an additional 20 years of operation can be safely accommodated onsite with small environmental effects through dry or pool storage at all plants, if a permanent repository or monitored retrievable storage is not available.
Offsite radiological impacts of spent nuclear fuel and high-level waste disposal.	1	For the high-level waste and spent-fuel disposal component of the fuel cycle, the EPA established a dose limit of 15 millirem (0.15 mSv) per year for the first 10,000 years and 100 millirem (1.0 mSv) per year between 10,000 years and 1 million years for offsite releases of radionuclides at the proposed repository at Yucca Mountain, Nevada. The Commission concludes that the impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent fuel and high level waste disposal, this issue is considered Category 1.

TABLE B–1—SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS [1]—Continued

Issue	Category [2]	Finding [3]
Mixed-waste storage and disposal	1	SMALL. The comprehensive regulatory controls and the facilities and procedures that are in place ensure proper handling and storage, as well as negligible doses and exposure to toxic materials for the public and the environment at all plants. License renewal would not increase the small, continuing risk to human health and the environment posed by mixed waste at all plants. The radiological and nonradiological environmental impacts of long-term disposal of mixed waste from any individual plant at licensed sites are small.
Nonradioactive waste storage and disposal.	1	SMALL. No changes to systems that generate nonradioactive waste are anticipated during the license renewal term. Facilities and procedures are in place to ensure continued proper handling, storage, and disposal, as well as negligible exposure to toxic materials for the public and the environment at all plants.
		Cumulative Impacts
Cumulative impacts	2	Cumulative impacts of license renewal must be considered on a plant-specific basis. Impacts would depend on regional resource characteristics, the resource-specific impacts of license renewal, and the cumulative significance of other factors affecting the resource.
		Uranium Fuel Cycle
Offsite radiological impacts—individual impacts from other than the disposal of spent fuel and high-level waste.	1	SMALL. The impacts to the public from radiological exposures have been considered by the Commission in Table S–3 of this part. Based on information in the GEIS, impacts to individuals from radioactive gaseous and liquid releases, including radon-222 and technetium-99, would remain at or below the NRC's regulatory limits.
Offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste.	1	There are no regulatory limits applicable to collective doses to the general public from fuel-cycle facilities. The practice of estimating health effects on the basis of collective doses may not be meaningful. All fuel-cycle facilities are designed and operated to meet the applicable regulatory limits and standards. The Commission concludes that the collective impacts are acceptable. The Commission concludes that the impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the collective impacts of the uranium fuel cycle, this issue is considered Category 1.
Nonradiological impacts of the uranium fuel cycle.	1	SMALL. The nonradiological impacts of the uranium fuel cycle resulting from the renewal of an operating license for any plant would be small.
Transportation	1	SMALL. The impacts of transporting materials to and from uranium-fuel-cycle facilities on workers, the public, and the environment are expected to be small.
		Termination of Nuclear Power Plant Operations and Decommissioning
Termination of plant operations and decommissioning.	1	SMALL. License renewal is expected to have a negligible effect on the impacts of terminating operations and decommissioning on all resources.

[1] Data supporting this table are contained in NUREG–1437, Revision 1, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants'' (XX 20XX).

[2] The numerical entries in this column are based on the following category definitions:

Category 1: For the issue, the analysis reported in the Generic Environmental Impact Statement has shown:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic;

(2) A single significance level (*i.e.*, small, moderate, or large) has been assigned to the impacts (except for collective off site radiological impacts from the fuel cycle and from high level waste and spent fuel disposal); and

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

The generic analysis of the issue may be adopted in each plant-specific review.

Category 2: For the issue, the analysis reported in the Generic Environmental Impact Statement has shown that one or more of the criteria of Category 1 cannot be met, and therefore additional plant-specific review is required.

[3] The impact findings in this column are based on the definitions of three significance levels. Unless the significance level is identified as beneficial, the impact is adverse, or in the case of ''small,'' may be negligible. The definitions of significance follow:

SMALL—For the issue, environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered small as the term is used in this table.

MODERATE—For the issue, environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

LARGE—For the issue, environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

For issues where probability is a key consideration (*i.e.*, accident consequences), probability was a factor in determining significance.

[4] NA (not applicable). The categorization and impact finding definitions do not apply to these issues.

[5] If, in the future, the Commission finds that, contrary to current indications, a consensus has been reached by appropriate Federal health agencies that there are adverse health effects from electromagnetic fields, the commission will require applicants to submit plant-specific reviews of these health effects as part of their license renewal applications. Until such time, applicants for license renewal are not required to submit information on this issue.

ORAL ARGUMENT NOT YET SCHEDULED

No. 20-1026

**IN THE UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT**

FRIENDS OF THE EARTH, NATURAL RESOURCES DEFENSE COUNCIL, INC., AND MIAMI WATERKEEPER,
Petitioners,

v.

UNITED STATES NUCLEAR REGULATORY COMMISSION AND UNITED STATES OF AMERICA,
Respondents.

Petition for Review of a Final Order of the
United States Nuclear Regulatory Commission

**DEFERRED JOINT APPENDIX
VOLUME 2 of 4**

JA00347 TO JA00915

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October 30, 2020

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United States Nuclear Regulatory Commission
Protecting People and the Environment

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Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Main Report

Final Report

Manuscript Completed: May 2013
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Office of Nuclear Reactor Regulation

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Summary

The Atomic Energy Act of 1954 authorizes the U.S. Nuclear Regulatory Commission (NRC) to issue commercial nuclear power plant operating licenses for up to 40 years and permits the renewal of the licenses as well. NRC regulations allow for the renewal of these operating licenses for up to an additional 20 years, depending on the outcome of safety and environmental reviews. There are no specific limitations in the Atomic Energy Act or the NRC's regulations restricting the number of times a license may be renewed.

The license renewal process is designed to assure safe operation of the nuclear power plant and protection of the environment during the license renewal term. Under the NRC's environmental protection regulations in Title 10, Part 51, of the *Code of Federal Regulations* (10 CFR Part 51), which implement Section 102(2) of the National Environmental Policy Act (NEPA), renewal of a nuclear power plant operating license requires the preparation of an environmental impact statement (EIS).

To support the preparation of these EISs, the NRC issued the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, in 1996. The original 1996 GEIS[(a)] for license renewal was prepared to assess the environmental impacts associated with the continued operation of nuclear power plants during the license renewal term. The NRC also promulgated a rule that codified the findings of the 1996 GEIS into its regulations at 10 CFR Part 51, Subpart A, Appendix B, Table B-1 (61 FR 28467, June 5, 1996). The intent was to determine which environmental impacts would result in essentially the same (generic) impact at all nuclear power plants and which ones could result in different levels of impacts at different plants and would require a plant-specific analysis to determine the impacts. For those issues that could not be generically addressed, the NRC would prepare plant-specific supplemental EISs (SEISs) to the GEIS.

The GEIS is intended to improve the efficiency of the license renewal process by (1) providing an evaluation of the types of environmental impacts that may occur from renewing commercial nuclear power plant operating licenses, (2) identifying and assessing impacts that are expected to be generic (the same or similar) at all nuclear plants (or plants with specific plant or site characteristics), and (3) defining the number and scope of environmental impact issues that need to be addressed in plant-specific EISs.

(a) Any reference in this document to the 1996 GEIS includes the two-volume set published in 1996 and Addendum 1 to the GEIS published in 1999.

As stated in the 1996 final rule that incorporated the findings of the GEIS in 10 CFR Part 51, the NRC recognized that environmental impact issues might change over time, and that additional issues may need to be considered. As further stated in the preamble to Table B-1, the NRC indicated that it intended to review the material in Table B-1 on a 10-year basis.
The NRC began this review on June 3, 2003, by publishing a notice of intent to revise the 1996 GEIS (68 FR 33209). As part of this process and pursuant to 10 CFR 51.29, the NRC conducted scoping and held a series of public meetings (*see* 74 FR 38119 for more details). The original public comment period began in June 2003 and closed in September 2003. The project was inactive for the next two years due to limited NRC staff resources and competing demands. On October 3, 2005 (70 FR 57628), the NRC reopened the public comment period and extended it until December 30, 2005.

On July 31, 2009 (74 FR 38117), the NRC published the proposed rule, "Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses," for public comment in the *Federal Register*. The proposed rule would amend Table B-1, by updating the Commission's 1996 findings on the environmental impacts related to the renewal of nuclear power plant operating licenses, and other NRC environmental protection regulations (e.g., 10 CFR 51.53, which sets forth the contents of the applicant's environmental report). Together with the proposed rule, the NRC also published a notice of availability of the draft revised GEIS (ADAMS Accession No. ML090220654); a proposed Revision 1 of Regulatory Guide (RG) 4.2, Supplement 1, "Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications" (ADAMS Accession No. ML091620409); and a proposed Revision 1 to NUREG–1555, Supplement 1, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants" (ADAMS Accession No. ML090230497), in the *Federal Register* (74 FR 38238). All of the documents requested public comments.

The proposed revision to the above documents were based on consideration of 1) comments received from the public during the public scoping period, 2) a review of comments received on plant-specific SEISs completed since the 1996 GEIS was issued, and 3) lessons learned and knowledge gained from previous and ongoing license renewal environmental reviews. The history of this rulemaking is discussed in more detail in the July 31, 2009 (74 FR 38117), proposed rule.

Since publication of the GEIS in 1996, approximately 40 nuclear plant sites (70 reactor units) have been the subject of plant-specific environmental reviews. This revision to the GEIS is intended to incorporate lessons learned and knowledge gained from these plant-specific environmental reviews, as well as changes to Federal laws and new information and research published since the 1996 GEIS.

S.1 Purpose and Need for the Proposed Action

The proposed action is the renewal of commercial nuclear power plant operating licenses. The NRC reviews each application submitted by licensees of operating nuclear power plants. A renewed license is just one of a number of conditions that licensees must meet if the licensee is to continue plant operations during the renewal term.

The purpose and need for NRC's proposed action is to provide an option to continue plant operations beyond the current licensing term to meet future system generating needs, as such needs may be determined by State, utility, system, and, where authorized, Federal (other than NRC) decision-makers. Unless there are findings in the safety review required by the Atomic Energy Act or in the NEPA environmental review that would lead the NRC to reject a license renewal application, the NRC has no role in the energy-planning decisions of power plant owners, State regulators, system operators, and, in some cases other Federal agencies, as to whether the plant should continue to operate.

In addition, the NRC has no authority or regulatory control over the ultimate selection of future replacement power alternatives. The NRC also cannot ensure that environmentally preferable replacement power alternatives are used in the future. While a wide range of replacement power alternatives are discussed in the GEIS, the only alternative to license renewal within NRC's decision-making authority is to not issue a renewed operating license. The impacts of not issuing a renewed operating license are addressed under the no-action alternative.

At some point, all nuclear power plants will terminate operations and undergo decommissioning. Under the no-action alternative, plant operations would be terminated at or before the end of the current license term. The no-action alternative, unlike the other alternatives, does not expressly meet the purpose and need of the proposed action, as it does not provide a means of meeting future electric system needs. No action, on its own, would likely create a need for replacement power, conservation and energy efficiency (demand-side management), purchased power, or some combination of these options.

A full range of replacement power alternatives are evaluated in the GEIS, including fossil fuel, new nuclear, and renewable energy sources. Conservation and power purchasing are also considered as replacement power alternatives to license renewal, because they represent other options for electric system planners.

S.2 Development of the Revised Generic Environmental Impact Statement

The GEIS documents the results of the systematic approach NRC used to evaluate the environmental consequences of renewing the licenses of commercial nuclear power plants and operating the plants for an additional 20 years beyond the current license term. The environmental consequences of license renewal include (1) impacts associated with continued operations and refurbishment activities similar to those that have occurred during the current license term; (2) impacts of various alternatives to the proposed action; (3) impacts from the termination of nuclear power plant operations and decommissioning after the license renewal term (with emphasis on the incremental effect caused by an additional 20 years of operation); (4) impacts associated with the uranium fuel cycle; (5) impacts of postulated accidents (design-basis accidents and severe accidents); (6) cumulative impacts of the proposed action; and (7) resource commitments associated with the proposed action, including unavoidable adverse impacts, the relationship between short-term use and long-term productivity, and irreversible and irretrievable commitment of resources. The environmental consequences of these activities are discussed in the GEIS.

In the 1996 GEIS, the NRC identified and assessed 92 environmental issues. This GEIS revision reviews and reevaluates the environmental impact issues and findings in the original GEIS. Experience gained from license renewal reviews conducted since the 1996 GEIS was published provides a source of new information for the evaluation presented in this revision. In addition, new research, findings, and other information were considered in evaluating the significance of impacts associated with license renewal. The purpose of the evaluation was to determine if the findings presented in the 1996 GEIS remain valid. In doing so, the NRC considered the need to modify, add to, group, or delete any of the 92 issues evaluated in the 1996 GEIS.

In a Notice of Intent published in the *Federal Register* on June 3, 2003, the NRC notified the public of its plan to revise the GEIS and to give people an opportunity to participate in the environmental scoping process. This step was the initial opportunity for public participation in the GEIS revision. In July 2003, the NRC held public scoping meetings in four locations (one in each of the four NRC regions)—Atlanta, Georgia; Oak Lawn, Illinois; Anaheim, California; and Boston, Massachusetts.

Participation in the scoping process by members of the public and local, State, Tribal, and Federal government agencies was encouraged and used to (1) determine the scope of the GEIS revision and identify whether there are any significant new issues that should be analyzed in depth; (2) identify and eliminate from detailed study those issues that are peripheral, are not significant, or have been covered by prior environmental reviews; (3) identify any environmental assessments and other EISs that are being or will be prepared that are related to, but are not part of, the scope of the proposed action; and (4) identify other environmental review and consultation requirements related to the proposed action.

The initial scoping period for this GEIS revision was from June 3, 2003, to September 17, 2003, but scoping was reopened between September 27, 2005, and December 30, 2005. The NRC staff reviewed the transcripts and all written material received during the scoping periods and identified individual comments. All comments and suggestions received orally during the scoping meetings or in writing were considered.

In evaluating the impacts of the proposed action and considering comments received from the public, agencies and other entities during the scoping period, the NRC identified 78 impact issues: 70 impact issues were associated with continued operations, refurbishment, and other supporting activities; 2 with postulated accidents; 1 with termination of plant operations and decommissioning; 4 with the uranium fuel cycle; and 1 with cumulative impacts. For all of these issues, the incremental effect of license renewal was the focus of the evaluation.

For each potential environmental impact issue, the revised GEIS (1) describes the nuclear power plant activity that could affect the resource, (2) identifies the resource that is affected, (3) evaluates past license renewal reviews and other available information, (4) assesses the nature and magnitude of the environmental impact on the affected resource, (5) characterizes the significance of the effect, (6) determines whether the results of the analysis apply to all nuclear power plants (whether the impact issue is Category 1, Category 2, or uncategorized), and (7) considers additional mitigation measures for adverse impacts.

The scope of the revised GEIS also evaluates the impacts of alternatives to license renewal, including replacement power generation (using fossil fuels, nuclear, and/or renewable energy), conservation and energy efficiency (demand-side management), and purchased power. It also evaluates the impacts from the no-action alternative (not renewing the operating license). This GEIS includes the NRC's evaluation of construction, operation, postulated accidents, decommissioning, and fuel cycles for these alternatives.

The NRC issued the revised GEIS as a draft on July 31, 2009; the NRC published a notice of the issuance in the *Federal Register* (34 FR 38238, July 31, 2009). The NRC also issued a proposed rule, which would codify the findings of the revised GEIS in Table B-1 of 10 CFR Part 51 as well as amend related 10 CFR Part 51 regulations (34 FR 38117, July 31, 2009). Both the notice issuing the draft revised GEIS and the proposed rule asked for public comments. The public comment period ran from July 31, 2009 to January 12, 2010. The NRC received several comment submissions (e.g., letters, e-mails), which contained, in aggregate, several hundred written comments. During the public comment period, the NRC also held six public meetings, which were transcribed (see ML093070141 for a summary of the public meetings).

All in-scope comments, both written and those received during the public meetings, were considered in preparing this revised GEIS.

S.3 Impact Definitions and Categories

The NRC's standard of significance for impacts uses the Council on Environmental Quality (CEQ) terminology for "significantly" (40 CFR 1508.27), which requires consideration of both "context" and "intensity." Based on this, the NRC established three levels of significance for potential impacts: SMALL, MODERATE, and LARGE. The definitions of the three significance levels, which are presented in the footnotes to Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, follow:

- SMALL impact: Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered SMALL.

- MODERATE impact: Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

- LARGE impact: Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

In addition to a determination of significance of environmental impacts associated with an issue, a determination was made whether the analysis in the GEIS could be applied to all nuclear plants (as well as to all plants with certain plant or site characteristics). Issues were assigned a Category 1 or Category 2 designation as follows:

Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics;

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste);

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required in future SEISs unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria of Category 1, and therefore, require additional plant-specific review.

S.4 Affected Environment

For purposes of the evaluation in this GEIS revision, the “affected environment” is the environment currently existing around operating commercial nuclear power plants. Current conditions in the affected environment are the result of past construction and operations at the plants. The NRC has considered the effects of these past and ongoing impacts and how they have shaped the environment. The NRC evaluated impacts of license renewal that are incremental to existing conditions. These existing conditions serve as the baseline for the evaluation and include the effects of past and present actions at the plants. It is this existing affected environment that comprises the environmental baseline against which potential environmental impacts of license renewal are evaluated.

The NRC described the affected environment in terms of the following resource areas and activities: (1) land use and visual resources; (2) meteorology, air quality, and noise; (3) geologic environment; (4) water resources (surface water and groundwater resources); (5) ecological resources (terrestrial resources, aquatic resources, special status species and habitats); (6) historic and cultural resources; (7) socioeconomics; (8) human health (radiological and nonradiological hazards); (9) environmental justice; and (10) waste management and pollution prevention. The affected environments of the operating plant sites represent diverse environmental conditions.

S.5 Impacts from Continued Operations and Refurbishment Activities Associated with License Renewal

NRC identified 78 impact issues from continued operations and refurbishment associated with license renewal. Seventeen of these issues were identified as Category 2 issues and would require plant-specific evaluations in future SEISs. The conclusions in each resource topical area are summarized here.

Land Use

- The impacts of continued operations and refurbishment on onsite land use would be SMALL. Changes in onsite land use from continued operations and refurbishment would be a small fraction of the nuclear power plant site and would only involve land that is controlled by the licensee. This is a Category 1 issue.

- The impacts of continued operations and refurbishment on offsite land use would be SMALL. Offsite land use would not be affected from continued operations and refurbishment associated with license renewal. This is a Category 1 issue.

- Use of transmission line right-of-ways (ROWs) would continue with no change in offsite land use restrictions. This is a Category 1 issue.

Visual Resources

- No important changes to the visual appearance (aesthetics) of plant structures or transmission lines are expected from continued operations and refurbishment. This is a Category 1 issue.

Air Quality

- Air quality impacts from continued operations and refurbishment activities would be SMALL. Emissions from refurbishment activities at locations in or near air quality nonattainment or maintenance areas would be short-lived and would cease once the activities are completed. Operating experience has shown that the scale of refurbishment activities has not resulted in exceedances in the *de minimis* thresholds for criteria pollutants. Best management practices, including fugitive dust controls and the imposition of permit conditions in State and local air emissions permits, would ensure conformance with applicable State or Tribal Implementation Plans. Emissions from emergency diesel generators and fire pumps and routine operations of boilers used for space heating would not be a concern, even for plants located in or adjacent to nonattainment areas. Impacts from cooling tower particulate emissions even under the worst-case situations have been SMALL. This is a Category 1 issue.

- Production of ozone and oxides of nitrogen from transmission lines is insignificant and does not contribute measurably to ambient levels of these gases. This is a Category 1 issue.

Noise Impacts

- The impacts of continued operations and refurbishment on offsite noise levels would be SMALL. Noise levels would remain below regulatory guidelines for offsite receptors. This is a Category 1 issue.

Geology and Soils

- The effect of geologic and soil conditions on plant operations and the impact of continued operations and refurbishment activities on geology and soils would be SMALL and would not change appreciably during the license renewal term. This is a Category 1 issue.

Surface Water Resources

- The non-cooling system impacts of continued operations and refurbishment on surface water use and quality would be SMALL if best management practices are employed to control soil erosion and spills. Surface water use would not increase significantly or would be reduced if refurbishment occurs during a plant outage. This is a Category 1 issue.

- Altered current patterns would be limited to the area in the vicinity of the intake and discharge structures. These impacts have been SMALL at operating nuclear power plants. This is a Category 1 issue.

- Effects on salinity gradients would be limited to the area in the vicinity of the intake and discharge structures. These impacts have been SMALL at operating nuclear power plants. This is a Category 1 issue.

- Effects on thermal stratification in lakes would be limited to the area in the vicinity of the intake and discharge structures. These impacts have been SMALL at operating nuclear power plants. This is a Category 1 issue.

- Scouring effects would be limited to the area in the vicinity of the intake and discharge structures. These impacts have been SMALL at operating nuclear power plants. This is a Category 1 issue.

- Discharges of metals in cooling system effluent have not been found to be a problem at operating nuclear power plants with cooling-tower-based heat dissipation systems and have been mitigated at other plants. Discharges are monitored as part of the National Pollutant Discharge Elimination System (NPDES) permit process. This is a Category 1 issue.

- The discharge and effects of biocides, sanitary wastes, and minor chemical spills are regulated by State and Federal environmental agencies. Discharges are monitored and controlled as part of the NPDES permit process. These impacts have been SMALL at operating nuclear power plants. This is a Category 1 issue.

- Surface water use conflicts have not been found to be a problem at operating nuclear power plants with once-through heat dissipation systems. This is a Category 1 issue.

- Surface water use conflicts could occur with nuclear power plants that rely on cooling ponds or cooling towers using makeup water from a river. Impacts could be SMALL or MODERATE, depending on makeup water requirements, water availability, and competing water demands. This is a Category 2 issue.

- Dredging to remove accumulated sediments in the vicinity of intake and discharge structures and to maintain barge shipping has not been found to be a problem for surface water quality. Dredging is performed under permit from the U.S. Army Corps of Engineers, and possibly, from State or local agencies. This is a Category 1 issue.

- Temperature effects on sediment capacity have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term. This is a Category 1 issue.

Groundwater Resources

- The non-cooling system impacts of continued operations and refurbishment on groundwater would be SMALL. Extensive dewatering is not anticipated during continued operations. Industrial practices involving the use of solvents, hydrocarbons, heavy metals, or other chemicals and/or the use of wastewater ponds or lagoons have the potential to contaminate site groundwater, soil, and subsoil. Contamination is subject to State or U.S. Environmental Protection Agency (EPA)-regulated cleanup and monitoring programs. The application of best management practices for handling any materials produced or used during these activities would reduce impacts. This is a Category 1 issue.

- Groundwater use conflicts are not anticipated for nuclear power plants that withdraw less than 100 gallons per minute. This is a Category 1 issue.

- Groundwater use conflicts with nearby groundwater users could occur with nuclear power plants that withdraw more than 100 gallons per minute. Impacts could be SMALL, MODERATE, or LARGE. This is a Category 2 issue.

- For plants with closed-cycle cooling systems that withdraw makeup water from a river, groundwater use conflicts could result from water withdrawals from rivers during low-flow conditions, which may affect aquifer recharge. The significance of impacts would depend on makeup water requirements, water availability, and competing water demands. The impacts on groundwater quality could be SMALL, MODERATE, or LARGE. This is a Category 2 issue.

- Groundwater withdrawals at operating nuclear power plants would not significantly degrade groundwater quality. This is a Category 1 issue.

- For plants with closed-cycle cooling ponds in salt marshes, groundwater quality could be degraded; the impact would be SMALL. However, groundwater in salt marshes is naturally brackish and thus, not potable. Consequently, the human use of such groundwater is limited to industrial purposes. This is a Category 1 issue.

- For plants with closed-cycle cooling ponds at inland sites, the impacts on groundwater quality could be SMALL, MODERATE, or LARGE. The significance of the impact would depend on cooling pond water quality; site hydrogeologic conditions (including the interaction of surface water and groundwater); and the location, depth, and pump rate of water wells. This is a Category 2 issue.

- Radionuclides released to groundwater, particularly tritium, due to inadvertent leaks of radioactive liquids from plant components and pipes could result in SMALL or MODERATE groundwater quality impacts. Such leaks have occurred at numerous plants. Groundwater protection programs have been established at all operating nuclear power plants to minimize the potential impact from any inadvertent releases. This is a Category 2 issue.

Terrestrial Resources

- Non-cooling system impacts of continued operations and refurbishment may affect terrestrial communities. Application of best management practices would reduce the potential for impacts. The magnitude of impacts (SMALL, MODERATE, or LARGE) would depend on the nature of the activity, the status of the resources that could be affected, and the effectiveness of mitigation. This is a Category 2 issue.

- The impacts of the exposure of terrestrial organisms to radionuclides would be SMALL. Doses to terrestrial organisms are expected to be well below exposure guidelines developed to protect these organisms. This is a Category 1 issue.

- Cooling system impacts on terrestrial resources would be SMALL for all nuclear plants with once-through cooling systems or cooling ponds. No adverse effects to terrestrial plants or animals have been reported as a result of increased water temperatures, fogging, humidity, or reduced habitat quality. Due to the low concentrations of contaminants in cooling system effluents, uptake and accumulation of contaminants are not expected to be significant. This is a Category 1 issue.

- Cooling tower operations and the impacts from salt drift, icing, fogging, or increased humidity associated with cooling tower operation have the potential to affect adjacent vegetation. However, these impacts have been SMALL at operating nuclear power plants and are not expected to change over the license renewal term. This is a Category 1 issue.

- Bird collisions with cooling towers and other plant structures and transmission lines occur at rates that are unlikely to affect local or migratory populations, and the rates are not expected to change during the license renewal term. This is a Category 1 issue.

- Water use conflicts with terrestrial resources for plants with cooling ponds or cooling towers using makeup water from a river could be SMALL or MODERATE. Impacts on terrestrial resources in riparian communities affected by water use conflicts could be of moderate significance in some situations. This is a Category 2 issue.

- Transmission line ROW management impacts on terrestrial resources would be SMALL. Continued ROW management is expected to keep terrestrial communities in their current condition. Application of best management practices would reduce the potential for impacts. This is a Category 1 issue.

- Impacts of electromagnetic fields on flora and fauna would be SMALL. No significant impacts of electromagnetic fields on terrestrial flora and fauna have been identified. Such effects are not expected to be a problem during the license renewal term. This is a Category 1 issue.

Aquatic Resources

- The impacts of impingement and entrainment of aquatic organisms could be SMALL, MODERATE, or LARGE at nuclear plants with once-through cooling systems or cooling ponds. The impacts are SMALL at many plants but may be MODERATE or even LARGE at a few plants, depending on cooling system withdrawal rates and volumes and the aquatic resources at the site. This is a Category 2 issue.

- The impacts of impingement and entrainment of aquatic organisms would be SMALL at plants with cooling towers. Impingement and entrainment rates are lower at plants that use closed-cycle cooling with cooling towers because the rates and volumes of water withdrawal needed for makeup are minimized. This is a Category 1 issue.

- Entrainment of phytoplankton and zooplankton has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term. This is a Category 1 issue.

- Thermal impacts on aquatic organisms could be SMALL, MODERATE, or LARGE at nuclear plants with once-through cooling systems or cooling ponds. Most of the effects associated with thermal discharges are localized and are not expected to affect overall stability of populations or resources. The magnitude of impacts would depend on site-specific thermal plume characteristics and the nature of aquatic resources in the area. This is a Category 2 issue.

- Thermal impacts on aquatic organisms associated with plants that use cooling towers would be SMALL because of the reduced amount of heated discharge. This is a Category 1 issue.

- Infrequently reported thermal impacts would be SMALL for all nuclear plants during the license renewal term. Cold shock has been satisfactorily mitigated at operating nuclear plants with once-through cooling systems, has not endangered fish populations or been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds, and is not expected to be a problem. Thermal plumes have not been found to be a problem at operating nuclear power plants and are not expected to be a problem. Thermal discharge may have localized effects but is not expected to affect the larger geographical distribution of aquatic organisms. Premature emergence has been found to be a localized effect at some operating nuclear power plants but has not been a problem and is not expected to be a problem. Stimulation of nuisance organisms has been mitigated at the single nuclear power plant with a once-through cooling system where previously it was a problem. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem. This is a Category 1 issue.

- The effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication are expected to result in SMALL impacts at all nuclear plants. Gas supersaturation was a concern at a small number of operating nuclear power plants with once-through cooling systems but has been satisfactorily mitigated. Low dissolved oxygen was a concern at one nuclear power plant with a once-through cooling system, but the problem has been effectively mitigated. Eutrophication (nutrient loading) and resulting effects on chemical and biological oxygen demands have not been found to be a problem at operating nuclear power plants. This is a Category 1 issue.

- The impacts of nonradiological contaminants on aquatic organisms would be SMALL. Best management practices and discharge limitations of NPDES permits are expected to minimize the potential for impacts to aquatic resources. Accumulation of metal contaminants has been a concern at a few nuclear power plants, but has been satisfactorily mitigated by replacing copper alloy condenser tubes with those of another metal. This is a Category 1 issue.

- The impacts of radionuclides on aquatic organisms would be SMALL. Doses to aquatic organisms are expected to be well below exposure guidelines developed to protect these organisms. This is a Category 1 issue.

- The effects of dredging on aquatic resources would be SMALL. Dredging at nuclear power plants is expected to occur infrequently, would be of relatively short duration, and would affect relatively small areas. Dredging is performed under permit from the U.S. Army Corps of Engineers, and possibly, from other State or local agencies. This is a Category 1 issue.

- Water use conflicts with aquatic resources for plants with cooling ponds or cooling towers using makeup water from a river could be SMALL or MODERATE. Impacts on aquatic resources in stream communities affected by water use conflicts could be of moderate significance in some situations. This is a Category 2 issue.

- The non-cooling system impacts of continued operations and refurbishment activities on aquatic resources would be SMALL. Licensee application of appropriate mitigation measures is expected to result in no more than small changes to aquatic communities from their current condition. This is a Category 1 issue.

- The impacts of transmission line ROW management on aquatic resources would be SMALL. Licensee application of best management practices to ROW maintenance is expected to result in no more than small impacts to aquatic resources. This is a Category 1 issue.

- Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses would be SMALL. These types of losses have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term. This is a Category 1 issue.

Special Status Species and Habitats

- The magnitude of impacts on threatened, endangered, and protected species, critical habitat, and essential fish habitat would depend on the occurrence of listed species and habitats and the effects of power plant systems on them. Consultation with appropriate agencies would be needed to determine whether special status species or habitats are present and whether they would be adversely affected by continued operations and refurbishment associated with license renewal. This is a Category 2 issue.

Historic and Cultural Resources

- Continued operations and refurbishment associated with license renewal are expected to have no more than small impacts on historic and cultural resources located onsite and in the transmission line ROWs because most impacts could be mitigated by avoiding those resources. The National Historic Preservation Act (NHPA) requires the Federal agency to consult with the State Historic Preservation Officer (SHPO) and Native American Tribes to determine the potential effects on historic properties and mitigation, if necessary. This is a Category 2 issue.

Socioeconomics

- Although most nuclear plants have large numbers of employees with higher than average wages and salaries, employment, income, recreation, and tourism, impacts from continued operations and refurbishment associated with license renewal are expected to be SMALL. This is a Category 1 issue.

- Impacts on tax revenues would be SMALL. Nuclear plants provide tax revenue to local jurisdictions in the form of property tax payments, payments in lieu of tax (PILOT) payments, or tax payments on energy production. The amount of tax revenue paid during the license renewal term as a result of continued operations and refurbishment associated with license renewal is not expected to change. This is a Category 1 issue.

- Changes to community services and education resulting from continued operations and refurbishment associated with license renewal would be SMALL. With little or no change in (1) employment at the licensee's plant, (2) value of the power plant, (3) payments on energy production, and (4) PILOT payments expected during the renewal term, community and educational services would not be affected by continued power plant operations. This is a Category 1 issue.

- Population and housing impacts would be SMALL as changes resulting from continued operations and refurbishment associated with license renewal to regional population and housing availability and value would be SMALL. With little or no change in employment at the licensee's plant expected during the license renewal term, population and housing availability and values would not be affected by continued power plant operations. This is a Category 1 issue.

- Transportation impacts would be SMALL as changes resulting from continued operations and refurbishment associated with license renewal to traffic volumes would be SMALL. This is a Category 1 issue.

Human Health

- Radiation doses to the public from continued operations and refurbishment associated with the license renewal term are expected to continue at current levels and would be well below regulatory limits. The impacts from radiation doses to the public would be SMALL. This is a Category 1 issue.

- Radiation doses to plant workers from continued operations and refurbishment associated with license renewal are expected to be within the range of doses experienced during the current license term and would continue to be well below regulatory limits. The impacts from radiation doses to plant workers would be SMALL. This is a Category 1 issue.

- Chemical hazards to plant workers resulting from continued operations and refurbishment associated with license renewal are expected to be minimized by the licensee implementing good industrial hygiene practices as required by permits and Federal and State regulations. Chemical releases to the environment and the potential for impacts to the public are expected to be minimized by adherence to discharge limitations of NPDES and other permits. The impacts from chemical hazards to plant workers would be SMALL. This is a Category 1 issue.

- Microbiological hazards to the public are not expected to be a problem at most operating plants but could result in SMALL, MODERATE, or LARGE impacts at plants with cooling ponds, lakes, canals, or that discharge to a river. Impacts would depend on site-specific characteristics. This is a Category 2 issue.

- Microbiological hazards to plant workers would be SMALL. Occupational health impacts are expected to be controlled by continued application of accepted industrial hygiene practices to minimize worker exposures as required by permits and Federal and State regulations. This is a Category 1 issue.

- The chronic effects of electromagnetic fields (EMFs) associated with nuclear plants and associated transmission lines are uncertain. Studies of 60-Hz EMFs have not uncovered consistent evidence linking harmful effects with field exposures. EMFs are unlike other agents that have a toxic effect (e.g., toxic chemicals and ionizing radiation) in that dramatic acute effects cannot be forced and longer-term effects, if real, are subtle. Because the state of the science is currently inadequate, no generic conclusion on human health impacts is possible. This issue has not been categorized.

- Physical occupational safety and health hazards are generic to all types of electrical generating stations, including nuclear power plants, and are of small significance if the workers adhere to safety standards and use personal protective equipment as required by Federal and State regulations. This is a Category 1 issue.

- Electric shock hazards could result in SMALL, MODERATE, or LARGE impacts. Electrical shock potential is of small significance for transmission lines that are operated in adherence with the National Electrical Safety Code (NESC). Without a review of conformance with NESC criteria of each nuclear power plant's in-scope transmission lines, it is not possible to determine the generic significance of the electrical shock potential. This is a Category 2 issue.

Postulated Accidents

- The environmental impacts of design-basis accidents are SMALL for all nuclear plants. Due to the requirements for nuclear plants to maintain their licensing basis and implement aging management programs during the license renewal term, the environmental impacts during a license renewal term should not differ significantly from those calculated for the design-basis accident assessments conducted as part of the initial plant licensing process. This is a Category 1 issue.

- For severe accidents, the probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are SMALL for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives. This is a Category 2 issue.

Environmental Justice

- Impacts to minority and low-income populations and subsistence consumption resulting from continued operations and refurbishment associated with license renewal will be addressed in plant-specific reviews. See NRC Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions (69 FR 52040, August 24, 2004). This is a Category 2 issue.

Waste Management and Pollution Prevention

- The impacts from low-level waste (LLW) storage and disposal would be SMALL. The comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts on the environment would remain SMALL during the license renewal term. This is a Category 1 issue.

- The impacts from onsite storage of spent nuclear fuel would be SMALL. The expected increase in the volume of spent fuel from an additional 20 years of operation can be safely accommodated onsite during the license renewal term with small environmental effects through dry or pool storage at all plants. This is a Category 1 issue.

- The impacts from offsite radiological impacts of spent nuclear fuel and high-level waste (HLW) disposal are uncertain. The issue is not categorized.

- The impacts from mixed-waste storage and disposal would be SMALL. The comprehensive regulatory controls and the facilities and procedures that are in place ensure proper handling and storage, as well as negligible doses and exposure to toxic materials for the public and the environment at all plants. License renewal would not increase the small continuing risk to human health and the environment posed by mixed waste at all plants. The radiological and nonradiological environmental impacts of long-term disposal of mixed waste from any individual plant at licensed sites are SMALL. This is a Category 1 issue.

- The impacts from nonradioactive waste storage and disposal would be SMALL. No changes to systems that generate nonradioactive waste are anticipated during the license renewal term. Facilities and procedures are in place to ensure continued proper handling, storage, and disposal, as well as negligible exposure to toxic materials for the public and the environment at all plants. This is a Category 1 issue.

Cumulative Impacts

- Cumulative impacts are those impacts on the environment that result from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions. The cumulative impacts of continued operations and refurbishment associated with license renewal must be considered on a plant-specific basis. Impacts would depend on regional resource characteristics, the resource-specific impacts of license renewal, and the cumulative significance of other factors affecting the resource. This is a Category 2 issue.

Uranium Fuel Cycle

- The individual offsite radiological impacts resulting from portions of the uranium fuel cycle, other than the disposal of spent fuel and HLW, would be SMALL. The impacts on individuals from radioactive gaseous and liquid releases during the license renewal term would remain at or below the NRC's regulatory limits. This is a Category 1 issue.

- With respect to the collective offsite radiological impacts from the uranium fuel cycle other than the disposal of spent fuel and HLW, there are no regulatory limits applicable to collective doses to the general public from fuel-cycle facilities. The practice of estimating health effects based on collective doses may not be meaningful. All fuel-cycle facilities are designed and operated to meet the applicable regulatory dose limits and standards. Accordingly, the Commission concludes that the collective impacts are acceptable. This is a Category 1 issue.

- The nonradiological impacts of the uranium fuel cycle resulting from the renewal of an operating license for any plant would be SMALL. This is a Category 1 issue.

- The impacts of transporting materials to and from uranium-fuel-cycle facilities on workers, the public, and the environment are expected to be SMALL. This is a Category 1 issue.

Termination of Nuclear Power Plant Operations and Decommissioning

- Termination of plant operations and decommissioning would occur eventually regardless of license renewal. The additional 20-year period of operation under the license renewal term would not affect the impacts of shutdown and decommissioning on any resource or at any plant. This is a Category 1 issue.

S.6 Comparison of Alternatives

The GEIS also evaluates the impacts of the proposed action (license renewal) and alternatives to license renewal, including the no-action alternative (not renewing the operating license). It also evaluates the impacts of replacement power alternatives (fossil fuels, nuclear, and renewable energy), conservation and energy efficiency (demand-side management), and purchased power. The impacts of renewing the operating license of a nuclear power plant are comparable to the impacts of energy alternatives. Replacement power alternatives would require the construction of a new power plant or modification of the electric transmission grid. The new power plants would also have operational impacts. Conversely, license renewal does not require major construction and operational impacts, which would not change beyond what is currently being experienced. Other alternatives that would not have construction or operational impacts include conservation and energy efficiency (demand-side management), delayed retirement, repowering, and purchased power.

Operational impacts of license renewal are comparable to replacement power alternatives and some renewable alternatives in some resource areas (socioeconomics) but quite different in other resource areas (air emissions, fuel cycle, land use, and water consumption). Renewable energy alternatives (wind, ocean wave, and ocean current alternatives) have very few operational impacts, while others (biomass combustion and conventional hydropower) can have considerable impacts. Some renewable energy alternatives (wind and solar) have relatively low but regionally variable capacity factors.

License renewal and alternatives differ in other respects, including the consequences of accidents. License renewal and new nuclear energy alternatives may have low-probability but potentially high-consequence accidents. In addition, fuel cycle impacts vary across alternatives. Some, like fossil fuel, require large amounts of land for fuel extraction.

Impacts from terminating power plant operations and decommissioning would vary between license renewal and the alternatives. License renewal delays the date of reactor shutdown and decommissioning but does not alter the impact levels. Impacts would be SMALL in all resource areas. In comparison, impacts from terminating operations and decommissioning of most alternatives would be larger than impacts from license renewal.

Under NEPA, the NRC has the obligation to consider reasonable alternatives to the proposed action of renewing the license for a nuclear reactor. The GEIS facilitates that alternative analysis by providing NRC review teams with empirical evidence of the performance, environmental impacts, and resource demands and impacts of those potential replacement power alternatives current as of the time this GEIS was prepared. A site-specific analysis of alternatives will be performed for each SEIS, taking into account changes in technology and science since the preparation of this GEIS.

1 Introduction

Contents of Chapter 1

The Atomic Energy Act of 1954 authorizes the U.S. Nuclear Regulatory Commission (NRC) to issue commercial nuclear power plant operating licenses for up to 40 years. The 40-year length of the original license period was imposed for economic and antitrust reasons rather than the technical limitations of the nuclear power plant. NRC regulations allow for the renewal of these operating licenses for up to an additional 20 years, depending on the outcome of an assessment determining whether the nuclear power plant can continue to operate safely and protect the environment during the 20-year period of extended operation. There are no specific limitations in the Atomic Energy Act or the NRC's regulations restricting the number of times a license may be renewed.

The license renewal process is designed to assure the safe operation of the nuclear power plant and protection of the environment for up to an additional 20 years. Under the NRC's environmental protection regulations in Title 10, Part 51 of the *Code of Federal Regulations* (10 CFR Part 51), which implement the National Environmental Policy Act (NEPA), renewal of a nuclear power plant operating license requires the preparation of an environmental impact statement (EIS).

To support the preparation of these EISs, the NRC prepared the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437 (NRC 1996, 1999). The original 1996 GEIS[a] for license renewal was prepared to assess the environmental impacts associated with the continued operation of nuclear power plants during the license

(a) Any reference in this document to the 1996 GEIS includes the two-volume set published in 1996 and Addendum 1 to the GEIS published in 1999.

renewal term. The intent of the GEIS is to determine which impacts would essentially be the same at all nuclear power plants and which ones could be different at different plants and would require a plant-specific analysis to determine the impacts.

1.1 Purpose of the GEIS

Generic Environmental Impact Statement (GEIS)

A GEIS is an environmental impact statement that assesses the scope and impact of the environmental effects that would be associated with an action (such as license renewal) at numerous sites.

Supplemental Environmental Impact Statement (SEIS)

A SEIS updates or supplements an existing EIS (such as the GEIS). The Commission directed the NRC staff to issue plant-specific supplements to the GEIS for each license renewal application.

The GEIS for license renewal of nuclear power plants assesses the environmental impacts that could be associated with license renewal and an additional 20 years of power plant operation. This assessment is summarized in this GEIS. This GEIS also provides the technical basis for license renewal amendments to the Commission's regulations, 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." In the 1996 GEIS and related rulemaking, the Commission determined that certain impacts associated with the renewal of a nuclear power plant operating license were the same or similar for all plants and could be treated on a generic basis. In this way, repetitive reviews of these impacts could be avoided. The Commission based its generic assessment of certain environmental impacts on the following factors:

(1) License renewal will involve nuclear power plants for which the environmental impacts of operation are well understood as a result of lessons learned and knowledge gained from operating experience and completed license renewals.

(2) Activities associated with license renewal are expected to be within this range of operating experience; thus, environmental impacts can be reasonably predicted.

(3) Changes in the environment around nuclear power plants are gradual and predictable.

The GEIS is intended to improve the efficiency of the license renewal process by (1) providing an evaluation of the types of environmental impacts that may occur from renewing commercial nuclear power plant operating licenses, (2) identifying and assessing impacts that are expected to be generic (the same or similar) at all nuclear plants (or plants with specified plant or site characteristics), and (3) defining the number and scope of environmental impact issues that need to be addressed in plant-specific EISs. The GEIS provides information that will aid the preparation of plant-specific EISs.

1.2 Description of the Proposed Action

> ***The Proposed Action***
>
> To renew commercial nuclear power plant operating licenses.
>
> ***Purpose and Need for the Proposed Action***
>
> To provide an option to continue plant operations beyond the current licensing term to meet future system generating needs.

Under NRC's environmental protection regulations in 10 CFR 51.20, renewal of a nuclear power plant operating license is identified as a major Federal action that requires the preparation of an EIS to address the impacts of renewing a plant's operating license. The EIS requirements for a plant-specific license renewal review are specified in 10 CFR 51.71 and 51.95. NRC's public health and safety and other technical requirements for the renewal of operating licenses are found in 10 CFR Part 54. Part 54 requires applicants to perform safety evaluations and assessments of nuclear power plants and provide the NRC with sufficient information to analyze the impacts of continued operation for the requested renewal term. Applicants are required to assess the effects of aging on passive and long-lived systems, structures, and components.

Most utilities are expected to begin preparation for license renewal about 10 to 20 years before expiration of their current operating licenses. Inspection, surveillance, test, and maintenance programs to support continued plant operations during the license renewal term would be integrated gradually over a period of years. Any refurbishment-type activities undertaken for the purposes of license renewal have generally been completed during normal plant refueling or maintenance outages before the original license expires. Activities associated with license renewal and operation of a plant for an additional 20 years are discussed in Chapter 2.

1.3 Purpose and Need for the Proposed Action

The Commission acts on each application submitted by a licensee for the renewal of commercial nuclear power plant operating licenses per Section 103 of the Atomic Energy Act. A renewed license is just one of a number of conditions that licensees must meet to operate its nuclear plant during the license renewal term. State regulators, system operators, and in some cases, other Federal agencies, ultimately decide whether the plant will continue to operate based on factors such as need for power or other factors within the State's jurisdiction or owner's control. Economic considerations play a primary role in this decision.

The purpose and need for the proposed action (issuance of a renewed license) is to provide an option that allows for baseload power generation capability beyond the term of the current nuclear power plant operating license to meet future system generating needs. Such needs may be determined by other energy-planning decision-makers, such as State, utility, and, where authorized, Federal agencies (other than the NRC). Unless there are findings in the safety review required by the Atomic Energy Act or the NEPA environmental review that would lead the NRC to reject a license renewal application, the NRC does not have a role in the energy-planning decisions of whether a particular nuclear power plant should continue to operate.

From the perspective of the licensee and the State regulatory authority, the purpose of renewing an operating license is to maintain the availability of the nuclear power plant to meet system energy requirements beyond the term of the plant's current license. In cases of interstate generation or other special circumstances, Federal agencies such as the Federal Energy Regulatory Commission (FERC) or the Tennessee Valley Authority (TVA) may be involved in making these decisions.

1.4 Alternatives to the Proposed Action

In license renewal environmental reviews, the NRC considers the environmental consequences of the proposed action, the no-action alternative (i.e., not renewing the operating license), and the environmental consequences of various alternatives for replacing the nuclear power plant's generating capacity. No conclusions are made in the GEIS about the relative environmental consequences of license renewal, the no-action alternative, and the construction and operation of alternative facilities for generating electric energy. However, information presented in the GEIS can be used by the NRC and applicants in performing the plant-specific analysis of alternatives.

In plant-specific environmental reviews, the NRC compares the environmental impacts of license renewal with those of the no-action alternative and replacement power alternatives to determine whether the adverse environmental impacts of license renewal are great enough to deny the option of license renewal for energy-planning decision-makers.

1.5 Analytical Approach Used in the GEIS

1.5.1 Objectives

The GEIS serves to facilitate NRC's environmental review process by identifying and evaluating environmental impacts that are considered generic and common to all nuclear power plants. Plant-specific impact issues will be addressed in separate supplemental EISs (SEISs) to the GEIS. Generic impacts will be reconsidered in SEISs only if there is new and significant information that would change the conclusions in the GEIS.

1.5.2 Methodology

Environmental impacts of license renewal and the resources that could be affected by continued operation and refurbishment were identified. The general analytical approach for identifying environmental impacts was to (1) describe the nuclear power plant activity that could affect the resource, (2) identify the resource that is affected, (3) evaluate past license renewal reviews and other available information, (4) assess the nature and magnitude of the environmental impact on the affected resource, (5) characterize the significance of the effects, and (6) determine whether the results of the analysis apply to all nuclear power plants (whether the environmental impact issue is Category 1 or Category 2, as described below). Identifying environmental impacts (or issues) was conducted in an iterative rather than a stepwise manner. For example, after information was collected and levels of significance were reviewed, impacts were reexamined to determine if any should be removed, added, consolidated, or divided.

1.5.2.1 Defining Environmental Issues

The 1996 GEIS presents the findings of a systematic inquiry into the environmental impacts of license renewal resulting in the identification of 92 environmental issues (or impacts), which were evaluated in the GEIS. Public and stakeholder comments on previous plant-specific license renewal reviews were analyzed in an effort to reevaluate the existing environmental issues and identify new issues. Environmental issues in this GEIS are arranged by resource area. This perspective is a change from the 1996 GEIS in which environmental issues were arranged by power plant systems.

1.5.2.2 Collecting Information

Information from completed license renewal environmental reviews was collected and reviewed. Searches of the open scientific literature, databases, and Web sites were conducted for each resource area. This information was collected and evaluated to determine if the environmental issues and findings in the 1996 GEIS needed to be revised.

1.5.2.3 Determining Significance Levels for Issues

A standard of significance was established for each license renewal environmental impact issue evaluated in the 1996 GEIS based on the Council on Environmental Quality (CEQ) terminology for “significantly” (see 40 CFR 1508.27). Since the significance and severity of an impact can vary with the setting of the proposed action, both “context” and “intensity,” as defined in CEQ regulations 40 CFR 1508.27, were considered. Context is the geographic, biophysical, and social context in which the effects will occur. In the case of license renewal, the context is the environment surrounding the nuclear power plant. Intensity refers to the severity of the impact in whatever context it occurs. Based on this, the NRC established three levels of significance for potential impacts: SMALL, MODERATE, and LARGE. The definitions of these three significance levels, which are presented in the footnotes to Table B–1 in Appendix B to Subpart A of 10 CFR Part 51, follow:

- SMALL—environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered SMALL.

- MODERATE—environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

- LARGE—environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The discussion of each environmental impact issue in the GEIS includes an explanation of how the significance category was determined. For issues in which the probability of occurrence is a key consideration (i.e., postulated accidents), the probability of occurrence has been factored into the determination of significance. Possible mitigation measures that could be used to avoid, minimize, rectify, reduce, eliminate, or compensate for adverse impacts are discussed where appropriate.

In addition to determining the significance of environmental impacts associated with an issue, a determination was made whether the analysis in the GEIS could be applied to all nuclear power plants. The categories to which an issue may be assigned are presented below.

- **Category 1**—the analysis reported in the GEIS has shown the following:

  (1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics;

  (2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel); and

  (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

- **Category 2**—the analysis reported in the GEIS has shown that one or more of the criteria of Category 1 cannot be met, and therefore, additional plant-specific review is required.

If all three Category 1 criteria apply to a particular issue, then the generic impact analysis presented in this GEIS is relied upon by the NRC in evaluating license renewal applications and plant-specific SEISs provided there is no new and significant information requiring further analysis. For issues that do not meet all three Category 1 criteria, the issue is considered a Category 2 issue, and a plant-specific impact analysis is required for that issue.

1.6 Scope of the GEIS Revision

The NRC assessed the impact of license renewal on 92 environmental issues for the 1996 GEIS. Impacts associated with 69 of these issues were determined to be generic (i.e., the same or similar at all plants), or Category 1. These issues are addressed in the 1996 GEIS and do not require a plant-specific assessment unless new and significant information is found that would change the conclusions in the GEIS. Guidance on plant-specific analyses required for the other 23 issues is provided in 10 CFR Part 51. Findings on the scope and magnitude of environmental impacts of renewing a nuclear power plant operating license in the GEIS as required by section 102(2) of NEPA are summarized in Table B–1 in Appendix B to Subpart A of 10 CFR Part 51 (Table B–1).

This GEIS reviews and reevaluates the issues and findings of the 1996 GEIS in compliance with the requirement to review the material in Appendix B to Subpart A of 10 CFR Part 51 and update it on a 10-year cycle, if necessary. Lessons learned and knowledge gained during previous license renewal reviews provided a significant source of new information for this review. Public comments received during previous license renewal environmental reviews were re-examined to validate existing environmental issues and identify new ones. Since 1996, over 40 commercial nuclear power plants have undergone a license renewal environmental review. The purpose of the review for this GEIS was to determine if the findings presented in the 1996 GEIS remain valid. In doing so, the NRC considered the need to modify, add, group, or delete any of the 92 environmental impact issues evaluated in the 1996 GEIS. In addition, new research, findings, and other information were considered when the significance of impacts associated with license renewal was being evaluated. After this review, the NRC carried forward 78 environmental impact issues for detailed consideration in this GEIS.

1.7 Decisions to Be Supported by the GEIS

The decisions to be to be supported by the GEIS are whether or not to renew the operating licenses of individual commercial nuclear power plants for an additional 20 years. The GEIS was developed to support these decisions and to serve as a basis from which future NEPA analyses for the license renewal of individual nuclear power plants would tier. According to CEQ guidelines (40 CFR 1508.28), tiering refers to "the coverage of general matters in broader environmental impact statements (such as national program or policy statements) with subsequent narrower statements or environmental analyses (such as regional or basinwide program statements or ultimately site-specific statements) incorporating by reference the general discussions and concentrating solely on the issues specific to the statement subsequently prepared…. Tiering in such cases is appropriate when it helps the lead agency to focus on the issues which are ripe for decision and exclude from consideration issues already decided or not yet ripe." The GEIS provides the NRC decision-maker with important environmental information considered common to all nuclear power plants and allows greater focus to be placed on plant-specific (i.e., Category 2) issues.

The scope of the environmental review for license renewal consists of the range of actions, alternatives, and impacts to be considered in an EIS. The purpose of scoping is to identify significant issues related to the proposed action. Scoping also identifies and eliminates from detailed study issues that are not significant or have been covered by a prior environmental review. Having a defined scope for the environmental review allows the NRC to concentrate on the essential issues resulting from the actions being considered rather than on issues that may have been or are being evaluated in different regulatory review processes, such as the license renewal safety review (NRC 2006).

The NEPA process focuses on environmental impacts rather than on issues related to safety. Safety issues become important to the environmental review when they could result in environmental impacts, which is why the environmental effects of postulated accidents are considered in the GEIS and in plant-specific supplements to the GEIS. Since NEPA regulations do not provide for a safety review, the license renewal process includes an environmental review that is distinct and separate from the safety review. Since the two reviews are separate, operational safety issues and safety issues related to nuclear power plant aging are considered outside the scope for the environmental review, just as the environmental issues are not considered as part of the safety review. However, safety issues that are raised during the environmental review are forwarded to the appropriate NRC organization for consideration and appropriate action (NRC 2006).

Actions subject to NRC approval for license renewal are limited to continued nuclear power plant operation consistent with the plant design and operating conditions for the current operating license and to the performance of specific activities and programs necessary to manage the effects of aging on the passive, long-lived structures and components identified in accordance with 10 CFR Part 54. Accordingly, the GEIS does not serve as the NEPA review for other activities or programs outside the scope of NRC's 10 CFR Part 54 license renewal review.

> ***Environmental Impact Statements***
>
> 10 CFR 51.70(b): The draft environmental impact statement … will state how alternatives considered in it and decisions based on it will or will not achieve the requirements of Sections 101 and 102(1) of NEPA. (See also the Council on Environmental Quality (CEQ) Regulations for Implementing NEPA, 40 CFR 1502.2(d).)

Separate NEPA reviews must be prepared regardless of whether the action is necessary as a consequence of receiving a renewed license, even if the activity were specifically addressed in the GEIS. For example, the environmental impacts of spent fuel pool expansion are addressed in the GEIS in the context of the environmental consequences of approving a renewed operating license. However, any specific application submitted to the NRC to expand spent fuel pool capacity at a given facility would still require its own separate NEPA review. These separate NEPA reviews may reference and otherwise use applicable environmental information contained in the GEIS. For example, an environmental assessment prepared for a separate spent fuel pool expansion request may use the information in the GEIS to support a finding of no significant impact (see June 5, 1996 Final Rule [61 FR 28467]).

There are many factors that NRC takes into consideration when deciding whether to renew the operating license of a nuclear power plant. The analyses of environmental impacts evaluated in this GEIS will provide NRC's decision-maker (in this case, the Commission) with important environmental information for use in the overall decision-making process. There are also decisions outside the regulatory scope of license renewal that cannot be made on the basis of the final GEIS analysis. These decisions include the following issues.

1.7.1 Changes to Plant Cooling Systems

The NRC will not make a decision or any recommendations on the basis of information presented in this GEIS regarding changes to nuclear power plant cooling systems, other than those involving safety-related issues, to mitigate adverse impacts under the jurisdiction of State or other Federal agencies. Implementation of the provisions of the Clean Water Act, including those regarding cooling system operations and design specifications, is the responsibility of the U.S. Environmental Protection Agency (EPA). In many cases, the EPA delegates such authority to the individual States. To operate a nuclear power plant, licensees must comply with the Clean Water Act, including associated requirements imposed by the EPA or the State, as part of the National Pollutant Discharge Elimination System (NPDES) permitting system under Section 402 of the Clean Water Act and State water quality certification requirements under Section 401 of the Clean Water Act. The EPA or the State, not the NRC, sets the limits of effluents and operational parameters in plant-specific NPDES permits. Nuclear power plants cannot operate without a valid[b] NPDES permit and a Section 401 Water Quality Certification.

1.7.2 Disposition of Spent Nuclear Fuel

The NRC will not make a decision or any recommendations on the basis of the information presented in this GEIS regarding the disposition of spent nuclear fuel at nuclear power plants. Within the context of a license renewal environmental review, the NRC concluded that the storage of spent nuclear fuel can be accomplished safely and without significant environmental impacts. The radiological impacts from the onsite storage of spent nuclear fuel to human health during the term of license renewal continue to be well within regulatory limits, and therefore, meet the standard for a conclusion of SMALL impact. Nonradiological environmental impacts also continue to be SMALL. The overall conclusion for onsite storage of spent nuclear fuel during the license renewal term is that the environmental impacts will be SMALL for each plant. Within the context of renewal, the NRC concludes that its regulatory requirements for spent nuclear fuel provide adequate protection of plant workers, the public, and the environment.

In 1982, the Congress enacted the Nuclear Waste Policy Act (NWPA), and on January 7, 1983, the President signed it into law. The NWPA defined the Federal Government's responsibility to provide permanent disposal in a deep geologic repository for spent fuel and high-level radioactive waste from commercial and defense activities. Under amended provisions (1987) of this Act, the U.S. Department of Energy (DOE) has the responsibility to locate, build, and operate a repository for such wastes. The NRC has the responsibility to establish regulations governing the construction, operation, and closure of the repository, consistent with environmental standards established by the EPA.

The 1987 amendments required DOE to evaluate only the suitability of the site at Yucca Mountain, Nevada, for a geologic disposal facility. In addition, the amendments outlined a detailed approach for the disposal of high-level radioactive waste involving review by the President, Congress, State and Tribal governments, NRC, and other Federal agencies. In February 2002, after many years of studying the suitability of the site, DOE recommended to the President that the Yucca Mountain site be developed as a long-term geologic repository for high-level waste. In April 2002, the Governor of Nevada notified Congress of his State's

(b) A valid NPDES permit is considered to be one that is either current (i.e., within its current effective date) or one that has expired but has been "administratively continued" by the permitting authority upon the timely submission of an applicant for renewal pursuant to the provisions of 40 CFR 122.6.

objection to the proposed repository. Subsequently, Congress voted to override the objection of the State.

DOE submitted a license application to the NRC for construction authorization for a repository at Yucca Mountain in June 2008. Upon acceptance of the application, the NRC started its technical evaluation. However, on March 3, 2010, the U.S. Department of Energy (DOE) filed a motion with the Atomic Safety and Licensing Board (Board) seeking permission to withdraw its application for authorization to construct a high-level waste geological repository at Yucca Mountain, Nevada. The Board denied that request on June 29, 2010, in LBP-10-11, and the parties filed petitions asking the Commission to uphold or reverse this decision. On October 1, 2010, the Commission directed the staff to perform an orderly closure of its Yucca Mountain activities. As part of the orderly closure, the NRC staff prepared three technical evaluation reports documenting its work.

On September 9, 2011, the Commission issued Memorandum and Order CLI-11-07, stating that it found itself evenly divided on whether to take the affirmative action of overturning or upholding the Board's June 29, 2010, decision. Exercising its inherent supervisory authority, the Commission directed the Board to complete all necessary and appropriate case management activities by September 30, 2011. On September 30, 2011, the Board issued a Memorandum and Order suspending the proceeding.

The NRC's non-sensitive Yucca Mountain-related documents are being preserved and made available to the public as part of the NRC staff's activities to retain the accumulated knowledge and experience gained as a result of its Yucca Mountain-related activities. These documents can be viewed on the NRC's public website (http://www.NRC.gov).

DOE decisions and recommendations concerning the ultimate disposition of spent nuclear fuel are ongoing and outside the regulatory scope of this GEIS.

Further, for the offsite disposal of spent nuclear fuel, the NRC's Waste Confidence Decision and Rule represented the Commission's generic determination that spent nuclear fuel can continue to be stored safely and without significant environmental impacts for a period of time after the end of the licensed life for operation of a nuclear power plant. This generic determination meant that the NRC did not need to consider the storage of spent nuclear fuel after the end of a reactor's licensed life for operation in the NEPA documents that support its reactor and spent-fuel storage license application reviews.

The NRC first adopted the Waste Confidence Decision and Rule in 1984. The NRC amended the decision and rule in 1990, reviewed them in 1999, and amended them again in 2010 (49 FR 34694 (August 31, 1984); 55 FR 38474 (September 18, 1990); 64 FR 68005 (December 6, 1999); and 75 FR 81032 and 81037 (December 23, 2010)). The NRC made a minor amendment to the rule in 2007 to clarify that it applies to combined licenses (72 FR 49509 (August 28, 2007)). The Waste Confidence Decision and Rule are codified in the NRC regulation 10 CFR 51.23.

On December 23, 2010, the Commission published in the *Federal Register* a revision of the Waste Confidence Decision and Rule to reflect information gained from experience in the storage of spent nuclear fuel and the increased uncertainty in the siting and construction of a permanent geologic repository for the disposal of spent nuclear fuel and high-level waste (75 FR 81032 and 81037). In response to the 2010 Waste Confidence Decision and Rule, the states of New York, New Jersey, Connecticut, and Vermont, along with several other parties challenged the Commission's NEPA analysis in the decision, which provided the regulatory basis for the rule. On June 8, 2012, the United States Court of Appeals, District of Columbia Circuit, in *New York v. NRC*, 681 F.3d 471 (D.C. Cir. 2012), vacated the NRC's Waste Confidence Decision and Rule, after finding that it did not comply with NEPA.

In response to the court's ruling, the Commission issued CLI-12-16 on August 7, 2012, in which the Commission determined that it would not issue licenses that rely upon the Waste Confidence Decision and Rule until the issues identified in the court's decision are appropriately addressed by the Commission. CLI-12-16 provided, however, that the decision not to issue licenses only applied to final license issuance; all licensing reviews and proceedings should continue to move forward. In SRM-COMSECY-12-0016, dated September 6, 2012, the Commission directed the NRC staff to proceed with a rulemaking that includes the development of a generic EIS to support a revised Waste Confidence Decision and Rule and to publish both the EIS and the revised decision and rule in the *Federal Register* within 24 months (by September 6, 2014). The Commission indicated that both the EIS and the revised Waste Confidence Decision and Rule should build on the information already documented in various NRC studies and reports, including the existing environmental assessment that the NRC developed as part of the 2010 Waste Confidence Decision and Rule. The Commission directed that any additional analyses should focus on the issues identified in the court's decision. The Commission also directed that the NRC staff provide ample opportunity for public comment on both the draft EIS and the proposed Waste Confidence Decision and Rule.

In accordance with CLI-12-16, the NRC will not approve any site-specific license renewal applications until the deficiencies identified in the court's decision have been resolved. Two license renewal GEIS issues that rely, wholly or in part, upon the Waste Confidence Decision and Rule are the "onsite storage of spent nuclear fuel" and "offsite radiological impacts of spent nuclear fuel and high-level waste disposal." Both of these issues were classified as Category 1 in the 10 CFR Part 51 rule that was promulgated in 1996; the 2009 proposed rule continued the Category 1 classification for both of these issues. As part of its response to the *New York v. NRC* decision, the NRC revised these two issues accordingly. Specifically, the NRC revised the Category 1 "Onsite storage of spent nuclear fuel" issue to narrow the period of onsite storage to the license renewal term. In both the 1996 rule (in which this issue was named "onsite spent fuel") and the 2009 proposed rule, the NRC relied upon the 1990 Waste Confidence Decision and Rule to make a generic finding that spent nuclear fuel could be stored safely onsite with no more than a small environmental impact for the term of the extended license (from approval of the license renewal application to the expiration of the operating license) plus a 30 year period following the permanent shutdown of the power reactor and expiration of the operating license.

The 1990 Waste Confidence Decision and Rule provided the basis for the 30 year period following the permanent shutdown of the reactor and expiration of the operating license. The 2010 Waste Confidence Decision and Rule extended this post-reactor shutdown onsite storage period from 30 years to 60 years. Given the *New York v. NRC* decision, and pending the issuance of a generic EIS and revised Waste Confidence Decision and Rule (as directed by SRM-COMSECY-12-0016), the period of onsite storage of spent nuclear fuel following the permanent shutdown of the power reactor and expiration of the operating license is now excluded from this GEIS issue. As revised, this issue now covers the onsite storage of spent fuel for the term of the extended license only.

Similarly, the NRC revised the Category 1 issue, "Offsite radiological impacts of spent nuclear fuel and high-level waste disposal" (this issue was named "offsite radiological impacts (spent fuel and high level waste disposal)" in the 1996 rule and GEIS). This issue pertains to the long-term disposal of spent nuclear fuel and high-level waste, including possible disposal in a deep geologic repository. Although the Waste Confidence Decision and Rule did not assess the impacts associated with disposal of spent nuclear fuel and high-level waste in a repository, it did reflect the Commission's confidence, at the time, in the technical feasibility of a repository and when that repository could have been expected to become available. Without the analysis in the Waste Confidence Decision, the NRC cannot assess how long the spent fuel will need to be stored onsite. Therefore, the NRC reclassifies this GEIS issue from a Category 1 issue with no assigned impact level to an uncategorized issue with an impact level of uncertain.

1.7.3 Emergency Preparedness

The NRC will not make a decision or any recommendations on the basis of information presented in this GEIS regarding emergency preparedness at nuclear power plants. Nuclear power plant owners, government agencies, and State and local officials work together to create a system for emergency preparedness and response that will serve the public in the unlikely event of an emergency. The emergency plans for nuclear power plants cover preparations for evacuation, sheltering, and other actions to protect residents near plants in the event of a serious incident.

In the United States, 104 commercial nuclear power reactors are licensed to operate at 65 sites in 31 States. For each site, there are onsite and offsite emergency plans to assure that adequate protective measures can be taken to protect the public in the event of a radiological emergency. Federal oversight of emergency preparedness for licensed nuclear power plants is shared by the NRC and Federal Emergency Management Agency (FEMA). The NRC and FEMA have a Memorandum of Understanding (44 CFR Appendix A to Part 353), under which FEMA has the lead in overseeing offsite planning and response, and the NRC assists FEMA in carrying out this role. The NRC has statutory responsibility for the radiological health and safety of the public and retains the lead for oversight of onsite preparedness.

Before a plant is licensed to operate, the NRC must have reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency. The NRC's decision of reasonable assurance is based on licensees complying with NRC regulations and guidance. In addition, licensees and area response organizations must demonstrate they can effectively implement emergency plans and procedures during periodic evaluated exercises. As part of the reactor oversight process, the NRC reviews licensees' emergency planning procedures and training. These reviews include regular drills and exercises that assist licensees in identifying areas for improvement, such as in the interface of security operations and emergency preparedness. Each plant owner is required to exercise its emergency plan with the NRC, FEMA, and offsite authorities at least once every two years to ensure that State and local officials remain proficient in implementing their emergency plans. Licensees also self-test their emergency plans regularly by conducting drills.

FEMA findings and determinations as to the adequacy and capability of implementing offsite plans are communicated to the NRC. The NRC reviews the FEMA findings and determinations as well as the onsite findings. The NRC then makes a determination on the overall state of emergency preparedness. These overall findings and determinations are used by the NRC to make radiological health and safety decisions before issuing licenses and in the continuing oversight of operating reactors. The NRC has the authority to take action, including shutting down any reactor deemed not to provide reasonable assurance of the protection of public health and safety.

The Commission considered the need for a review of emergency planning issues in the context of license renewal during its rulemaking proceedings on 10 CFR Part 54, which included public notice and comment. As discussed in the statement of consideration for rulemaking (56 FR 64966), the programs for emergency preparedness at nuclear power facilities apply to all nuclear power facility licensees and require the specified levels of protection from each licensee regardless of plant design, construction, or license date. Requirements related to emergency planning are in the regulations at 10 CFR 50.47 and Appendix E to 10 CFR Part 50. These requirements apply to all operating licenses and will continue to apply to facilities with renewed licenses. Through its standards and required exercises, the Commission reviews existing emergency preparedness plans throughout the life of any facility, keeping up with changing demographics and other site-related factors.

Therefore, the Commission has determined that there is no need for a special review of emergency planning issues in the context of an environmental review for license renewal (NRC 2006). Thus, decisions and recommendations concerning emergency preparedness at nuclear plants are ongoing and outside the regulatory scope of license renewal.

1.7.4 Safeguards and Security

The NRC requires that nuclear power plants be both safe and secure. Safety refers to operating the plant in a manner that protects the public and the environment. Security refers to protecting the plant (using people, equipment, and fortifications) from intruders who wish to damage or destroy it in order to harm people and the environment.

Security issues such as safeguards planning are not tied to a license renewal action but are considered to be issues that need to be dealt with continuously as a part of a nuclear power plant's current (and renewed) operating license. Security issues are periodically reviewed and updated at every operating plant. These reviews continue throughout the period of an operating license, whether it is the original or renewed license. If issues related to security are discovered at a nuclear plant, they are addressed immediately, and any necessary changes are reviewed and incorporated under the operating license (NRC 2006). As such, decisions and recommendations concerning safeguards and security at nuclear power plants are ongoing and outside the regulatory scope of this GEIS.

1.7.5 Need for Power

The NRC will not make a decision or any recommendations on the basis of information presented in this GEIS regarding the need for power at nuclear power plants. The regulatory authority over licensee economics (including the need for power) falls within the jurisdiction of the States and, to some extent, within the jurisdiction of FERC. The proposed rule for license renewal published on September 17, 1991 (56 FR 47016), had originally included a cost-benefit analysis and consideration of licensee economics as part of the NEPA review. However, during the comment period, State, Federal, and licensee representatives expressed concern about the use of economic costs and cost-benefit balancing in the proposed rule and the 1996 GEIS. They noted that CEQ regulations interpret NEPA to require only an assessment of the cumulative effects of a proposed Federal action on the natural and man-made environment and that the determination of the need for generating capacity has always been a State responsibility. For this reason, the purpose and need for license renewal was defined by the Commission in the June 5, 1996, final rule as follows (61 FR 28467):

> The purpose and need for the proposed action (renewal of an operating license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized, Federal (other than NRC) decision-makers.

10 CFR 51.95(c)(2) states:

> The supplemental environmental impact statement (SEIS) for license renewal is not required to include discussion of need for power or the economic costs and economic benefits of the proposed action or of alternatives to the proposed action except insofar as such benefits and costs are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation.

1.7.6 Seismicity and Flooding

The NRC will not make a decision or any recommendations on the basis of information presented in this GEIS regarding seismic risk and flooding at nuclear power plants. The NRC's assessment of seismic and flood hazards for existing nuclear power plants is a separate and distinct process from license renewal reviews. Seismic and flood hazard issues are addressed by the NRC on an ongoing basis at all licensed nuclear facilities. As such, decisions and recommendations concerning seismic risk and flooding at nuclear power plants are outside the regulatory scope of this GEIS. Nevertheless, following the accident at the Fukushima Dai-ichi nuclear power plant resulting from the March 11, 2011, Great Tohoku Earthquake and subsequent tsunami, the NRC established the Near-Term Task Force as directed by the Commission on March 23, 2011, in COMGBJ-11-0002. The Japan Near-Term Task Force assessment resulted in the issuance of 10 CFR 50.54 (f) letters on March 12, 2012, directing that seismic and flooding reevaluations be conducted at existing nuclear power plants (NRC 2012).

1.8 Implementation of the Rule (10 CFR Part 51)

1.8.1 General Requirements

The regulatory requirements for conducting a NEPA review for license renewal are similar to the NEPA review requirements for other major plant licensing actions. Consistent with the current NEPA practice for major plant licensing actions, an applicant is required to submit an environmental report that assesses the environmental impacts associated with the proposed action, considers alternatives to the proposed action, and evaluates any alternatives for reducing adverse environmental effects. For license renewal, the NRC prepares a draft SEIS to the GEIS for public comment and issues a final SEIS after considering public comments on the draft.

1.8.2 Applicant's Environmental Report

The applicant's environmental report must contain an assessment of the environmental impacts of renewing a license, the environmental impacts of alternatives, and mitigation alternatives. In preparing the analysis of environmental impacts contained in the environmental report, the applicant should refer to the information provided in Table B-1 of 10 CFR Part 51. The applicant is not required to assess the environmental impacts of Category 1 issues listed in Table B-1 unless the applicant is aware of new and significant information that would change the conclusions in the GEIS. For Category 2 issues listed in Table B-1, the applicant must provide a plant-specific assessment of the impacts. 10 CFR 51.53(c)(3)(ii) specifies the areas that must be addressed for the Category 2 issues in the environmental report.

10 CFR 51.45(c) and 10 CFR 51.53(c)(2) require the applicant to consider alternatives available for reducing or avoiding adverse environmental effects associated with the proposed action. This consideration is limited to designated Category 2 issues. Pursuant to 10 CFR 51.45(d), the environmental report must include a discussion of the status of compliance with applicable Federal, State, and local environmental standards. Also, 10 CFR 51.53(c)(2) specifically excludes from consideration in the environmental report the issues of need for power, the economic costs and benefits of the proposed action, economic costs and benefits of alternatives to the proposed action, or other issues not related to environmental effects of the proposed action and associated alternatives. NRC regulations do not require a discussion of the economic costs and benefits of these alternatives in the environmental report for license renewal, except as necessary to determine whether an alternative should be included in the range of alternatives considered or whether certain mitigative actions are appropriate. The analysis should also demonstrate consideration of a range (set) of reasonable alternatives to license renewal. In preparing the alternatives analysis, the applicant is not limited to the technologies presented in this GEIS. Information provided in the applicant's environmental report will be used in preparing the NRC's SEIS.

1.8.3 NRC's SEIS

As required by 10 CFR 51.20(b)(2), the NRC is required to prepare a SEIS to the GEIS for each license renewal application. The SEIS will serve as the NRC's analysis of the environmental impacts of license renewal as well as a comparison of these impacts to the environmental impacts of alternatives. This document will also present the NRC's recommendation as to the environmental impact of license renewal. SEISs for license renewal do not need to include a discussion of the need for power or the economic costs and economic benefits of the proposed action or of alternatives to the proposed action (10 CFR 51.95(c)(2)).

1.8.4 Public Scoping and Public Comments

NRC conducts public scoping meetings in order to inform the public about the license renewal process and receive comments on the scope of the NRC's plant-specific environmental review. At the conclusion of the scoping period, NRC reviews and addresses public comments in a scoping summary report. In addition, the draft SEIS is issued for public comment (see 10 CFR 51.73). In both the scoping and the public comment process, the NRC will consider comments and will determine whether these comments provide any information that is new and significant compared with that previously considered in the GEIS (for Category 1 issues). If the comments are determined to provide new and significant information that could change the conclusions in the GEIS, these comments will be considered and addressed in the SEIS.

1.8.5 NRC's Draft SEIS

The NRC's draft SEIS will include its analysis of the environmental impacts of the proposed license renewal action and the environmental impacts of the alternatives to the proposed action. The NRC will utilize and integrate (1) the environmental impacts of license renewal as provided in Table B-1 of 10 CFR Part 51 for Category 1 issues, (2) the appropriate plant-specific analyses of Category 2 issues, and (3) any new and significant information identified in the applicant's environmental report or during the scoping and public comment process to arrive at a conclusion regarding the environmental impacts of license renewal. These impacts are compared to the environmental impacts of the alternatives presented in the SEIS.

1.8.6 NRC's Final SEIS

The NRC will issue a final SEIS in accordance with 10 CFR 51.91 and 51.93 after considering (1) the public comments, (2) the analysis of Category 2 issues, and (3) any new and significant information involving Category 1 issues. The NRC will provide a record of its decision regarding the environmental impacts of the proposed license renewal action (see 10 CFR 51.102 and 51.103). All comments on the draft SEIS will be addressed by the NRC in the final SEIS in accordance with 10 CFR 51.91(a)(1). Comments will be addressed in the following manner:

(a) NRC's response to a comment regarding the applicability of the analysis of an impact codified in the rule (i.e., 10 CFR Part 51) to the plant in question may be a statement and explanation of its view that the analysis is adequate including, if applicable, consideration of the significance of new information. A commenter dissatisfied with such a response may file a petition for rulemaking under 10 CFR 2.802. Procedures for the submission of petitions for rulemaking are explained in 10 CFR Part 2. If a commenter is successful in persuading the Commission that the new information does indicate that the analysis of an impact codified in the rule is incorrect in significant respects (either in general or with respect to the particular plant), then a rulemaking proceeding will be initiated.

(b) If a commenter provides new information that is relevant to the plant and is also relevant to other plants (i.e., generic information) and that information demonstrates that the analysis of an impact codified in the rule is incorrect, the NRC will seek Commission approval either to suspend the application of the rule on a generic basis with respect to the analysis or to delay granting the renewal application (and possibly other renewal applications) until the rule can be amended. This GEIS would reflect the corrected analysis and any additional consideration of alternatives as appropriate.

(c) If a commenter provides new, site-specific information that demonstrates that the analysis of an impact codified in the rule is incorrect with respect to the particular plant, then the NRC staff will seek Commission approval to waive the application of the rule with respect to that analysis in that specific renewal proceeding. The SEIS would reflect the corrected analysis as appropriate.

1.9 Public Comments on the Draft GEIS

The public comment process for the GEIS was similar to that used for SEISs and other NRC NEPA documents. In July 2009, NRC distributed the draft GEIS to Federal, State, and local government agencies; American Indian Tribes; environmental interest groups; and members of the public who requested copies. As part of the process to solicit public comments on the draft GEIS, the NRC:

- Placed a copy of the draft GEIS into the NRC's Public Electronic Reading Room and on its license renewal Web site;
- Sent copies of the draft GEIS to members of the public and environmental interest groups, representatives of American Indian Tribes, and Federal, State, and local agencies;
- Published a notice of availability of the draft GEIS in the *Federal Register* (74 FR 38239);
- Published a notice of an extension to the comment period from 75 to 165 days (74 FR 51522);

- Issued public announcements, such as advertisements in local newspapers and postings in public places, of the availability of the draft GEIS;

- Announced and held public meetings in (1) Atlanta, Georgia, on September 15, 2009; (2) Newton, Massachusetts, on September 17, 2009; (3) Oak Brook, Illinois, on September 24, 2009; (4) Rockville, Maryland, on October 1, 2009; (5) Pismo Beach, California, on October 20, 2009; and (6) Dana Point, California, on October 22, 2009, to receive public comments on the draft GEIS;

- Issued public service announcements and press releases announcing the issuance of the draft GEIS, the public meetings, and instructions on how to comment on the draft GEIS; and

- Established several methods for the submittal of comments on the draft GEIS, including an e-mail address to receive comments through the Internet.

During the public comment period, the NRC received a total of 32 comment letters, e-mails, and Web submissions in addition to comments received during the public meetings. The NRC reviewed public meeting transcripts and comment letters, which have been incorporated by reference in this GEIS. The public meeting transcripts and comment letters have also been made available online in the Agencywide Documents Access and Management System (ADAMS) (see GEIS Appendix A).

The NRC used public comments gathered during the meetings and comment period when developing the final GEIS. NRC responses to comments are included in GEIS Volume 2, Appendix A, Section A.2. Comments were received on a variety of topics, including (1) land use and visual impacts; (2) air quality, meteorology, and climatology; (3) soils, geology, and seismology; (4) water quality, hydrology, and use; (5) aquatic ecology, terrestrial ecology, and threatened and endangered species; (6) historic and cultural resources; (7) socioeconomics; (8) human health; (9) uranium fuel cycle and waste management; (10) cumulative impacts; (11) alternatives to license renewal; (12) postulated accidents; and (13) decommissioning. In addition, comments were received on the overall license renewal process and in opposition to nuclear power. Some comments received were editorial in nature or were considered outside of the scope of the license renewal environmental review process.

Some of the more frequently mentioned issues and their disposition in the final GEIS are described in the following paragraphs. Note that these issues are not presented in any particular order.

Seismic issues. Many commenters wanted seismic issues to be included in the rule and pointed out the importance of reassessing seismic conditions in determining the safety of operating nuclear power plants. Industry commenters disagreed and argued that seismology should not be considered part of the issue of "Impacts of nuclear plants on geology and soils" in the proposed rule because it is an ongoing safety issue that is being addressed at all plants.

The NRC agrees with the commenters that consideration of seismic conditions is an ongoing safety issue. Although seismic conditions at nuclear power plants are generically discussed in the GEIS as part of the geologic environment, seismology is not identified as a separate issue in the GEIS because the NRC considered historical earthquake data for each nuclear power plant when that plant was first licensed. The NRC requires all licensees to take seismic activity into account in order to maintain safe operating conditions at all nuclear power plants. When new seismic hazard information becomes available, the NRC evaluates the new data and models to determine if any changes are needed at existing plants regardless of whether or not a plant has renewed its license. This reactor oversight process, which includes seismic safety, remains separate from license renewal.

Unrelated to license renewal, the NRC completed the Generic Issues Program Safety/Risk Assessment Stage for Generic Issue 199 in August 2010, "Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants," which evaluated recent updates to estimates of the seismic hazard in the central and eastern United States (NRC 2010a,b). The results of the Generic Issue 199 Safety/Risk Assessment indicated that the currently operating nuclear power plants have adequate safety margin for seismic issues. The NRC's assessment indicated that overall seismic risk estimates remain SMALL, and adequate protection is maintained. The NRC's path forward for Generic Issue 199 is described in NRC Information Notice 2010–18 (NRC 2010b). It provided notice of NRC's intent to follow the appropriate regulatory process to request that operating nuclear power plants and independent spent fuel storage installations provide specific information relating to their facilities to enable the NRC staff to complete the appropriate backfit analyses (see 10 CFR 50.109) where candidate backfits would be identified and evaluated. NRC then developed a draft generic letter to request needed data from power reactor licensees. However, following the accident at the Fukushima Dai-ichi nuclear power plant resulting from the March 11, 2011 Great Tohoku Earthquake and subsequent tsunami, the NRC established the Near-Term Task Force as directed by the Commission. The Japan Near-Term Task Force assessment resulted in the issuance of 10 CFR 50.54(f) letters on March 12, 2012, that addressed GI-199 in its entirety in recommendations 2.1 and 2.3 regarding seismic and flooding reevaluations, respectively (NRC 2012). The NRC's Japan Lessons Learned Project Directorate has now assumed the work of GI-199, including the evaluation of information received and actions taken by power reactor licensees in response to the March 12, 2012 10 CFR 50.54(f) letters.

The NRC's assessment of seismic hazards for existing nuclear power plants is a separate and distinct process from license renewal reviews. Seismic hazard issues are being addressed by the NRC on an ongoing basis at all licensed nuclear facilities. Sections 3.4 and 4.4.1 of the

GEIS explain that geologic and seismic conditions were considered in the original design of nuclear power plants and are part of the license bases for operating plants. Seismic conditions are attributes of the geologic environment that are not affected by continued plant operations and refurbishment and are not expected to change appreciably during the license renewal term for all nuclear power plants.

Air quality impacts. Several commenters objected to the issue "Air quality (non-attainment and maintenance areas)" being listed as a Category 2 issue in the proposed rule. The commenters argued that air quality impacts would be SMALL even in worst-case situations because licensees are required to operate within State air permit requirements.

The NRC agrees with the commenters. Operating experience has shown that the potential impact from emergency generators and boilers on air quality would be SMALL for all plants and, given the infrequency and short duration of maintenance testing, would not be an air quality concern even at plants located in or adjacent to nonattainment areas. Based on these comments, NRC technical staff re-evaluated this issue and determined that air quality impacts would be SMALL for all plants, and the issue should be Category 1. The GEIS was revised to explain this determination.

In addition, recent analysis has shown that the worst-case emissions from cooling tower drift and particulate emissions at operating plants were also SMALL. Air quality impacts from vehicle, equipment, and fugitive dust emissions associated with refurbishment would be SMALL for most plants, but could be a cause for concern for plants located in or near air quality nonattainment or maintenance areas. However, the impacts would be temporary and would cease once projects were completed. In addition, operating experience has shown that refurbishment activities have not required the large numbers of workers and extended durations conservatively predicted and analyzed in the 1996 GEIS, nor have such activities resulted in exceedances in the *de minimis* thresholds for criteria pollutants in nonattainment and maintenance areas. Consequently, the NRC agrees with the commenters' arguments that air quality impacts would be SMALL for all plants and should be a Category 1 issue.

Groundwater and soil contamination. Several commenters objected to the new Category 2 issue, "Groundwater and soil contamination," in the proposed rule and draft GEIS and asserted that contamination from industrial practices is addressed by U.S. Environmental Protection Agency (EPA) and State regulations that monitor and address these impacts. Specifically, the use, storage, disposal, release, and/or cleanup of spilled or leaked solvents, hydrocarbons, and other potentially hazardous materials are governed by the Resource Conservation and Recovery Act (RCRA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Toxic Substances Control Act (TSCA), Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and the Clean Water Act (CWA).

While classified as a Category 2 issue in the draft GEIS and proposed rule, further consideration of the "Groundwater and soil contamination" issue and public comments revealed that the potential impacts on groundwater and soil quality from common industrial practices (e.g., the use, handling, storage, and disposal of chemicals, petroleum products, waste, and hazardous material) can be addressed generically, as industrial practices employed by nuclear power plants are not unique but common to all industrial facilities. The NRC concludes that the overall impact of industrial practices on groundwater use and quality from past and current operations is SMALL for all nuclear power plants and not expected to change appreciably during the license renewal term. NRC agrees with the commenters to the extent that clarification was needed and that common industrial practices which can cause groundwater or soil contamination can be addressed generically as a Category 1 issue.

Further, the final rule and GEIS combine the re-classified "Groundwater and soil contamination" issue with the Category 1 "Groundwater use and quality" issue and renames the consolidated Category 1 issue as "Groundwater contamination and use (non-cooling system impacts)." These issues were consolidated because they both consider the impact of industrial activities associated with the continued operations of a nuclear power plant (not directly related to cooling system effects) on groundwater use and quality. Consolidating these issues also conforms to the resource-based approach used in this revised GEIS and serves to facilitate the license renewal environmental review process.

The previous findings for "Groundwater use and quality," as analyzed in the 1996 GEIS, indicated that impacts of continued operations and refurbishment on groundwater use and quality would be SMALL, as extensive dewatering is not anticipated, and the application of best management practices for handling any materials produced or used during activities would reduce impacts. These findings were re-evaluated in the draft GEIS and are retained in this final GEIS.

This new consolidated issue also considers the impacts on groundwater, soil, and subsoil from the industrial use of solvents, hydrocarbons, heavy metals, or other chemicals at nuclear power plant sites during the license renewal term, including the impacts resulting from the use of wastewater disposal ponds or lagoons (both lined or unlined). Industrial practices at all nuclear plants have the potential to contaminate groundwater and soil, especially on sites with unlined wastewater and storm water lagoons. Contaminants have been found in groundwater and soil samples at some nuclear power plants during previous license renewal environmental reviews.

Any groundwater and soil contamination at operating nuclear power plants is subject to characterization and cleanup under EPA and State-regulated remediation and monitoring programs. In addition, wastewater disposal ponds and lagoons are subject to discharge authorizations under NPDES and related State wastewater discharge permit programs. Each operating nuclear power plant must comply with these EPA and State regulatory requirements.

As such, each site has an established program for handling chemicals, waste, and other hazardous materials. Moreover, nuclear power plant licensees are expected to employ best management practices, both in minimizing effluents and in remediation. Thus, this new consolidated issue, as explained in the final GEIS and rule, is a Category 1 issue.

Radionuclides in groundwater. Several commenters expressed opposition to the inclusion of a new Category 2 issue "Radionuclides released to groundwater," with an impact estimate of SMALL to MODERATE in the proposed rule and draft GEIS. Some commenters indicated that the issue category should be changed to Category 1; others suggested that the levels of significance should range from SMALL to LARGE. The argument for changing the issue to Category 1 was based on the voluntary industry-wide initiative (NEI 07-07, *Industry Ground Water Protection Initiative—Final Guidance Document*; NEI 2007) designed to protect groundwater.

This new Category 2 issue evaluates the potential contamination and degradation of groundwater resources resulting from inadvertent discharges of radionuclides into groundwater from nuclear power plants. Within the past several years, there have been numerous events at power reactor sites which involved unknown, uncontrolled, and unmonitored releases of radionuclides into the groundwater. The number of these events and the high level of public controversy have made this issue one that the NRC believes needs a "hard look" as required by NEPA.

As a voluntary action, NEI 07–07 cannot be enforced by the NRC. As such, no violations can be issued against a licensee who fails to comply with the guidance in NEI 07-07. Furthermore, the NRC cannot rely on a voluntary initiative as a basis to ensure that the nuclear power industry will have adequate information available for the NRC to determine whether a documented leak or spill does or does not have an adverse impact on groundwater resources. Regarding the magnitude of impact, the NRC bases its determination of SMALL to MODERATE impact on a review of existing plants have had inadvertent releases of radioactive liquids. Even though the NRC expects impacts for all plants to be within this range, a conclusion of LARGE impact would not be precluded for a future license renewal review based on new and significant information if the data support such a conclusion. As reflected in the final GEIS and rule, "Radionuclides released to groundwater" remains a Category 2 issue.

Radiation exposure to the public. Many commenters identified recent studies that claim an association between cancer risk and proximity to nuclear power facilities.

The NRC's primary mission is to protect the public health and safety and the environment from the effects of radiation from nuclear reactors, materials, and waste facilities. The NRC's regulatory limits for radiological protection are set to protect workers and the public from the harmful health effects (i.e., cancer and other biological impacts) of radiation to humans. The limits are based on the recommendations of scientific standards-setting organizations. These radiation standards reflect extensive scientific study by national and international organizations. The NRC actively participates in and monitors the work of these organizations to remain current on the latest trends in radiation protection. If the NRC determines that there is a need to revise its radiation protection regulations, it will initiate a separate rulemaking. The models recognized by the NRC for use by licensees to calculate dose incorporate conservative assumptions to ensure that workers and members of the public are adequately protected from radiation.

On April 7, 2010, the NRC announced that it asked the National Academy of Sciences (NAS) to perform a state-of-the-art study on cancer risk for populations surrounding nuclear power facilities (ADAMS Accession No. ML100970142). The NAS has a broad range of medical and scientific experts who can provide the best available analysis of the complex issues involved in discussing cancer risk and commercial nuclear power plants. The NAS is a nongovernmental organization chartered by the U.S. Congress to advise the nation on issues of science, technology, and medicine. Through the National Research Council and Institute of Medicine, it carries out studies independently of the government, using processes designed to promote transparency, objectivity, and technical rigor. More information on its methods for performing studies is available at http://www.nationalacademies.org/studycommitteprocess.pdf.

The NAS study will update the 1990 U.S. National Institutes of Health National Cancer Institute (NCI) report, "Cancer in Populations Living Near Nuclear Facilities" (Jablon et al. 1991), which concluded there was no evidence that nuclear facilities may be linked casually with excess death from leukemia or from other cancers in populations living nearby. The study's objectives are to (1) evaluate whether cancer risk is different for populations living near nuclear power facilities; (2) include cancer occurrence; (3) develop an approach to assess cancer risk in geographic areas that are smaller than the county level; and (4) evaluate the study results in the context of offsite doses from normal reactor operations. The study began in the summer of 2010 and is expected to be completed within three years. A discussion about NRC's sponsorship of this follow-up study is in Section 3.9.1.3 of the GEIS.

Onsite storage of spent nuclear fuel, waste disposal, and Yucca Mountain. Please see section 1.7.2, "Disposition of Spent Nuclear Fuel," above.

Postulated accidents. Numerous comments were received on the NRC's evaluation and classification of postulated accidents. One commenter disagreed with the GEIS's conclusion that environmental impact from design basis accidents (DBAs) is SMALL. Also, several commenters disagreed with the GEIS conclusion that the environmental impact from severe accidents is SMALL, and further, that the evaluation is not adequate because of its use of probability-weighted risk assessments. Their position is that for severe accidents, the revised GEIS should also evaluate the consequences of reactor accidents and expand the evaluation to include spent fuel pool accidents and accidents due to age-related plant component degradation. In addition, some of the commenters stated that the NRC has gained enough information from the many plant licenses it has renewed to make a determination, on a generic basis, that the “Severe accidents” issue should be reclassified as Category 1.

Design Basis Accidents. The NRC does not agree that the GEIS’s evaluation of DBAs is incorrect. The NRC evaluates and presents the potential consequences of DBAs in nuclear power plant licensing documents and considers them in the GEIS for license renewal. In order to receive NRC approval for an initial operating license, an applicant must submit a final safety analysis report (FSAR) as part of its application. The FSAR presents the applicable design criteria and design information for the proposed reactor, as well as comprehensive data on the proposed site. The FSAR also discusses hypothetical reactor accident situations and addresses the safety features that prevent and mitigate those accidents. During the initial licensing process for a power reactor, the NRC reviews the FSAR to determine whether or not the plant design meets the NRC’s regulations.

At initial licensing, the NRC also considered the environmental impact of DBAs at each operating nuclear power plant. DBAs are those events that both the applicant and the NRC evaluate to ensure that the plant can withstand normal and abnormal transients (e.g., rapid changes in reactor power) without undue risk to the health and safety of the public. Although the NRC does not expect that all of these postulated events will occur during the life of the plant, the NRC evaluates them to establish the basis for the preventive and mitigative safety systems of the facility. The acceptance criteria for DBAs are described in 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” and 10 CFR Part 100, “Reactor Site Criteria.” Compliance with these regulations provides reasonable assurance of adequate protection of public health and safety.

During operations, the NRC requires that each power plant licensee maintains acceptable design and performance criteria in accordance with the NRC regulations, including during any license renewal period. Therefore, the calculated releases from DBAs will remain within the NRC regulatory limits.

The 1996 GEIS, in Section 5.2, discusses the impacts of potential accidents. It contains a discussion of plant accidents and consequences. This discussion addresses general characteristics of design basis (and severe) accidents, characteristics of fission products, meteorological considerations, possible exposure pathways, potential adverse health effects, avoiding adverse health effects, accident experience and observed impacts, and emergency preparedness. This GEIS reexamined the information from the 1996 GEIS and concluded that it is still valid. Because the information on DBAs is valid and has not changed, this GEIS does not repeat the information from the 1996 GEIS.

Severe Accidents. The NRC does not agree with the comments that the GEIS evaluation is inadequate regarding the impacts from severe accidents because it uses probability-weighted risk assessments. Severe accidents (i.e., beyond design-basis accidents) are those that could result in substantial damage to the reactor core, whether or not there are serious off-site consequences. The 1996 GEIS estimated and considered the potential impacts on human health and economic factors from full-power severe reactor accidents initiated by internal events at different types of nuclear facilities located in different types of settings. That evaluation included modeling the release of radioactive materials into the environment and modeling the pathways (i.e., exposure to the radioactive plume, inhalation of radioactivity, consumption of contaminated food) through which members of the public could potentially be exposed to doses of radiation. Based on the calculated doses, the 1996 GEIS reported the consequences (i.e., potential early and latent fatalities) from such accidents. In developing a potential impact level, however, the NRC took into account the very low probability of such events, as well as their potential consequences, and concluded that the likely impact from individual nuclear power plants is small.

In this GEIS, the NRC expanded the scope of the severe accident evaluations and used more recent technical information that included both internal and external event core-damage frequency, as well as improved severe accident source terms, spent fuel pool accidents, low power and reactor shutdown events, new radiation risk-coefficients from the National Academy of Sciences, "Health Risks from Exposure to Low Levels of Ionizing Radiation: Biological Effects of Ionizing Radiation (BEIR) VII report," and risk impacts of reactor power uprates and higher fuel burn-up levels. As a result, this GEIS considers updated information in determining the potential consequences of a reactor accident. Considering this updated information and that severe reactor accidents remain unlikely, this GEIS concludes that the environmental impacts of a severe accident remain small.

The NRC notes, however, that the GEIS is not the primary vehicle the NRC uses to address and regulate risks from severe accidents. The NRC's regulations and regulatory practices employ safety standards in the design, construction, and operation of nuclear power plants as well as risk models to ensure the public is adequately protected on an on-going basis. The NRC 's ongoing oversight addresses the public's risk from nuclear power plant accidents, accounts for the effects of proposed changes that may be made as part of power plant operations, and considers new information about the facility or its environment when necessary.

Although the NRC has determined that impacts from severe accidents are small for all facilities, the NRC continues to maintain that severe accidents cannot be a Category 1 issue because plant-specific mitigation measures vary greatly based on plant designs, safety systems, fuel type, operating procedures, local environment, population, and siting characteristics. Thus, severe accidents remain a Category 2 issue. Accordingly, the NRC has not changed the requirements in 10 CFR 51.53(c)(3)(ii)(L) that an applicant's environmental report must contain a discussion that considers alternatives to mitigate severe accidents if the NRC has not previously considered this issue in an environmental impact statement or environmental assessment for the facility.

Spent Fuel Pool Accidents. The 1996 GEIS included a quantitative analysis of a severe accident involving a reactor operating at full power. A qualitative evaluation of SFP accidents is presented in Appendix E of this GEIS. Based on this evaluation, this GEIS concludes that the environmental impacts from accidents involving SFPs are comparable to those from the reactor accidents at full power that were evaluated in the 1996 GEIS, and as such, SFP accidents do not warrant separate evaluation. Based on the continued validity of conclusions from the 1996 GEIS, as affirmed by the Commission (see following paragraph), this GEIS does not contain a quantitative evaluation of SFP accidents.

The issue of an accident involving the spent fuel was specifically addressed by the NRC in response to two Petitions for Rulemaking (PRM), PRM-51-10 and PRM-51-12, submitted by the Attorney General of the Commonwealth of Massachusetts in 2006 and the Attorney General of California in 2007, respectively (collectively, the Petitioners). The Petitioners challenged the 1996 GEIS Category 1 classification for this issue.[c] The Petitioners requested that the NRC initiate a rulemaking concerning the environmental impacts of the high-density storage of spent nuclear fuel in spent fuel pools (SFPs). The Petitioners asserted that ‘‘new and significant information’’ showed that the NRC incorrectly characterized the environmental impacts of high-density spent fuel storage as ‘‘insignificant’’ in the 1996 GEIS for the renewal of nuclear power plant licenses. Specifically, the Petitioners asserted that spent fuel stored in high-density SFPs is more vulnerable to a zirconium fire than the NRC concluded in its NEPA analysis.

On August 8, 2008 (73 FR 46204), the Commission denied the petitions, stating:

> Based upon its review of the petitions, the NRC has determined that the studies upon which the Petitioners rely do not constitute new and significant information. The NRC has further determined that its findings related to the storage of spent nuclear fuel in pools, as set forth in NUREG-1437 and in Table B-1, of Appendix B to Subpart A of 10 CFR Part 51, remain valid. Thus, the NRC has met and continues to meet its obligations under NEPA. For the reasons discussed previously, the Commission denies PRM-51-10 and PRM-51-12.[d]

(c) The details of the petitions and the NRC’s evaluations of those petitions are available to the public through the ADAMS electronic reading room (at www.nrc.gov using ADAMS accession number ML073310115) and in the Federal e-Rulemaking Portal (http://www.regulations.gov, Docket ID [NRC-2006-0022] (PRM-51-10), and [NRC-2007-0019] (PRM-51-12)).

(d) 73 FR 46204, 46212 (August 8, 2008). The NRC decision to deny the two rulemaking petitions was upheld by the United States Court of Appeals for the Second Circuit. *New York v. the Nuclear Regulatory Commission*, 589 F.3d 551 (2nd Cir. 2009).

Based on the continued validity of conclusions from the 1996 GEIS, and as affirmed by the Commission in its denial of PRM-51-10 and PRM-51-12, the NRC concludes that the onsite storage of spent fuel is properly classified as Category 1.

Aging-Related Degradation. Issues related to age-related plant component degradation are addressed in the NRC's safety evaluation of the plant's license renewal application. The regulations covering the safety review for license renewal are in 10 CFR Part 54.

The 1996 GEIS discusses the potential effects of age on the physical plant and notes that such deterioration could result in an increased likelihood of component or structure failure that could increase the rate of plant accidents. The GEIS notes that the NRC requires an applicant for license renewal address the issue of age-related degradation by identifying, in an integrated plant assessment process, those passive, long-lived structures and components that are susceptible to age-related degradation and whose functions are necessary to ensure that the facility's current licensing basis will be maintained in the license renewal period. The GEIS found that the safety evaluation performed by the NRC as part of the license renewal process provides reasonable assurance that age-related degradation will be managed and adequate protection of the health and safety of the public will be maintained during the license renewal period. Therefore, the 1996 GEIS concluded "the probability of any radioactive releases from accidents will not increase over the license renewal period." Based on nuclear power plants' continued compliance with 10 CFR Part 54 to manage age-related degradation, this GEIS did not alter or revise this conclusion.

Climate change. Several commenters discussed the need to include a discussion of the effects of climate change on plant operations and the effect of continued operations during the license renewal period on environmental resources affected by climate change.

Like other Federal agencies, the NRC has begun to evaluate the effects of greenhouse gas (GHG) emissions and its implications for global climate change in its environmental reviews for both new reactor and license renewal applications. Changes in climate have the potential to affect air and water resources, ecological resources, and human health, and should be taken into account when evaluating cumulative impacts over the license renewal term.

Subsequent to the publication of the proposed rule and during the public comment period, the Commission issued a memorandum and order concerning two combined license applications for new reactor units at the Tennessee Valley Authority Bellefonte site in Alabama and the Duke Energy Carolinas Lee site in South Carolina (CLI–09–21, November 3, 2009). The memorandum and order stated:

> [B]ecause the Staff is currently addressing the emerging issues surrounding greenhouse gas emissions in environmental reviews required for the licensing of nuclear facilities, we believe it is prudent to provide the following guidance to the Staff. We expect the Staff to include consideration of carbon dioxide and other greenhouse gas emissions in its environmental reviews for major licensing actions under the National Environmental Policy Act. The Staff's analysis for reactor applications should encompass emissions from the uranium fuel cycle as well as from construction and operation of the facility to be licensed. The Staff should ensure that these issues are addressed consistently in agency NEPA evaluations and, as appropriate, update Staff guidance documents to address greenhouse gas emissions.[e]

Presently, insufficient data exists to support an impact level on a generic basis. The NRC only has direct emission data for a handful of facilities. Although some States have varying reporting requirements, GHG emissions reporting nationwide is in its infancy. The EPA promulgated its GHG emissions reporting rule on October 30, 2009 (74 FR 56260). In accordance with this rule, the first industry reporting date was March 31, 2011.[f] Moreover, the 25,000 annual metric ton reporting threshold EPA established in the above final rule are not an indication of what EPA considers to be a significant (or insignificant) level of GHG emissions on a scientific basis, but a threshold chosen by EPA for policy evaluation purposes.[g]

In order to comply with the Commission's direction in CLI–09–21 and in response to the comments received, a new section, "GHG Emissions and Climate Change" (Chapter 4, Section 4.12.3.2), summarizing the potential cumulative impacts of GHG emissions and global climate change, has been added to the final GEIS. The NRC will also include within each SEIS a plant-specific analysis of any impacts caused by GHG emissions over the course of the license renewal term as well as any cumulative impacts caused by potential climate change upon the affected resources during the license renewal term. The final rule was not revised to include any reference to GHG emissions or climate change.

Recent advances in (replacement power alternatives. Several commenters asserted that much of the information describing replacement power alternatives did not reflect the state-of-

(e) In the matter of Duke Energy Carolinas, LLC (Combined License Application for William States Lee III Nuclear Station, Units 1 and 2); in the matter of Tennessee Valley Authority (Bellefonte Nuclear Power Plant, Units 3 and 4), CLI–09–21 (NRC November 3, 2009).

(f) 74 FR 56260, 56267 (October 30, 2009), codified at 40 CFR 98.3(b) ("The annual GHG report must be submitted no later than March 31 of each calendar year for GHG emissions in the previous calendar year").

(g) EPA concluded for policy evaluation purposes, the 25,000 metric ton threshold more effectively targets large industrial emitters and suppliers, covers approximately 85 percent of U.S. emissions, and minimizes the burden on smaller facilities.

the-science. In some cases, commenters noted facts and events that occurred after the publication date of the draft GEIS.

The NRC has updated the final GEIS to incorporate the latest information on replacement power alternatives, but it is inevitable that rapidly evolving technologies will outpace information presented in the GEIS. Incorporation of this information is more appropriately made in the context of plant-specific license renewal reviews, rather than in the GEIS. As with renewable energy technologies, energy policies are evolving rapidly. While the NRC acknowledges that legislation, technological advancements, and public policy can underlie a fundamental paradigm shift in energy portfolios, the NRC cannot make decisions based on anticipated or speculative changes. Instead, the NRC considers the status of alternatives and energy policies when conducting plant-specific environmental reviews. The introduction to GEIS Section 2.3.4 has been revised to clarify NRC's approach to evaluating replacement power alternatives.

Emergency preparedness and security. Many commenters expressed concern with emergency preparedness, evacuation, and safety and security planning at nuclear power plants. Commenters stated that these concerns were not adequately covered in the draft GEIS and should be included in the scope of plant-specific license renewal supplements to the GEIS.

As explained in GEIS Section 1.7.3, emergency preparedness and planning are part of a nuclear power plant's current operating license. Before a nuclear power plant is licensed to operate, the NRC must have "reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency" (10 CFR 50.47). Therefore, the Commission determined that decisions and recommendations concerning emergency preparedness at nuclear plants are ongoing and outside the regulatory scope of license renewal.

The Commission considered the need for a review of emergency planning issues in the context of license renewal during its rulemaking proceedings on 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," which included public notice and comment. As discussed in the Statement of Consideration for rulemaking (56 FR 64966; December 13, 1991), the programs for emergency preparedness at nuclear power facilities apply to all nuclear power facility licensees and require the specified levels of protection from each licensee regardless of plant design, construction, or license date. NRC requirements related to emergency planning are in the regulations at 10 CFR 50.47 and Appendix E to 10 CFR Part 50, "Emergency Planning and Preparedness for Production and Utilization Facilities." These requirements apply to all operating licenses and will continue to apply to facilities with renewed licenses. Through its standards and required exercises, the Commission reviews existing emergency preparedness plans throughout the life of any facility, keeping up with changing demographics and other site-related factors.

Further, the NRC actively reviews its regulatory framework to ensure that the emergency preparedness regulations are current and effective. The agency began a major review of its emergency preparedness framework in 2005, including a comprehensive review of the emergency preparedness regulations and guidance, the issuance of generic communications regarding the integration of emergency preparedness and security, and outreach efforts to interested persons to discuss emergency preparedness issues. In 2011, these activities culminated in the issuance of a final rule that enhances a nuclear power plant's response to possible hostile action events by making drill and exercise programs more challenging, changing the criteria for declaring emergencies, and taking additional steps to protect workers. The rule also includes other new requirements such as when updates to evacuation time estimates are required.

As explained in GEIS Section 1.7.4, security issues are not tied to a license renewal action but are considered to be issues that need to be dealt with continuously as a part of the current (and renewed) operating license. If issues related to security are discovered at a nuclear plant, they are addressed immediately, and any necessary changes are reviewed and incorporated under the current operating license (NRC 2006). For example, after the terrorist attacks of September 2001, the NRC issued security-related orders and guidance to nuclear power plants. These orders and guidance included interim measures for emergency planning. Nuclear industry groups and Federal, State, and local government agencies assisted in the prompt implementation of these measures and participated in drills and exercises to test these new planning elements. The NRC reviewed licensees' commitments to address these requirements and verified their implementation through inspections to ensure public health and safety.

In summary, the issue of security (and risk from terrorist acts against nuclear power plants) is not unique to facilities requesting license renewal. The NRC routinely assesses threats and other information provided by other Federal agencies and sources. The NRC also ensures that licensees meet their security requirements through its ongoing regulatory process (routine inspections) as a current and generic regulatory issue that affects all nuclear power plants. Therefore, as discussed in the Statements of Consideration for the 10 CFR Part 54 rulemaking, the Commission has determined that there is no need for a special review of security issues in the context of an environmental review for license renewal.

Fukushima earthquake and tsunami. On March 11, 2011, a massive earthquake off the east coast of Honshu, Japan, produced a devastating tsunami that struck the coastal town of Fukushima. The six-unit Fukushima Dai-ichi nuclear power plant was directly impacted by these events. The resulting damage caused the failure of several of the units' safety systems needed to maintain cooling water flow to the reactors. As a result of the loss of cooling, the fuel overheated, and there was a partial meltdown of the fuel contained in several of the reactors. Damage to the systems and structures containing reactor fuel resulted in the release of radioactive material to the surrounding environment.

In response to the earthquake, tsunami, and resulting reactor accidents at Fukushima Dai-ichi (hereafter referred to as the “Fukushima events”), the Commission directed the staff to convene an agency taskforce (Japan Near-Term Task Force) of senior leaders and experts to conduct a methodical and systematic review of the relevant NRC regulatory requirements, programs, and processes, including their implementation, and to recommend whether the agency should make near-term improvements to its regulatory system. As part of the short-term review, the taskforce concluded that, while improvements are expected to be made as a result of the lessons learned from the Fukushima events, the continued operation of nuclear power plants and licensing activities for new plants do not pose an imminent risk to public health and safety (NRC 2011).

During the time that the taskforce was conducting its review, groups of individuals and non-governmental organizations petitioned the Commission to suspend all licensing decisions in order to conduct a separate, generic NEPA analysis to determine whether the Fukushima events constituted “new and significant information” under NEPA that must be analyzed as part of environmental reviews. The Commission found the request premature and noted, “In short, we do not know today the full implications of the [Fukushima] events for U.S. facilities.”[h] However, the Commission found that if “new and significant information comes to light that requires consideration as part of the ongoing preparation of application-specific NEPA documents, the agency will assess the significance of that information, as appropriate.”[i] The Federal courts of appeal and the Commission have interpreted NEPA such that an EIS must be updated to include new information only when that new information provides “a seriously different picture of the environmental impact of the proposed project from what was previously envisioned.”[j]

In the context of the GEIS, the Fukushima events are considered a severe accident (i.e., a type of accident that may challenge a plant’s safety systems at a level much higher than expected) and more specifically, a severe accident initiated by an event external to the plant. The 1996 GEIS concluded that risks from severe accidents initiated by external events (such as an earthquake) could have potentially high consequences but found that external events are adequately addressed through a consideration of a severe accident initiated by an internal event (such as a loss of cooling water). Therefore, an applicant for license renewal need only analyze

(h) *Union Electric Co. d/b/a Ameren Missouri* (Callaway Plant, Unit 2), CLI-11-05, 74 NRC __, __ (slip op. at 30) (Sept. 9, 2011).

(i) *Id.* at 30-31.

(j) *Id*. at 31 (quoting *Hydro Resources, Inc.* (2929 Coors Road, Suite 101, Albuquerque, NM 87120), CLI-99-22, 50 NRC 3, 14 (1999) (citing *Marsh v. Oregon Natural Resources Council*, 490 U.S. 360, 373 (1989))). The Commission also noted that it can modify a facility’s operating license outside of a renewal proceeding and made clear that “it will use the information from these activities to impose any requirement it deems necessary, irrespective of whether a plant is applying for or has been granted a renewed operating license.” *Id.* at 26-27.

the environmental impacts from an internal event in order to adequately characterize the environmental impacts from either type of event. Prior to the Fukushima events, this GEIS examined more recent and up-to-date information regarding external events and concluded that the analysis in the 1996 GEIS remains valid.

Meanwhile, the Japan Near-Term Task Force assessment resulted in the issuance of 10 CFR 50.54(f) letters on March 12, 2012, to address seismic and flooding reevaluations (NRC 2012). As of the publication date of this GEIS, the NRC's evaluation of the consequences of the Fukushima events is ongoing under the direction of the NRC's Japan Lessons Learned Project Directorate. As such, the NRC will continue to evaluate the need to make improvements to existing regulatory requirements based on the task force report and additional studies and analyses of the Fukushima events as more information is learned. To the extent that any revisions are made to NRC regulatory requirements, they would be made applicable to nuclear power reactors regardless of whether or not they have a renewed license. Therefore, no additional analyses have been performed in this GEIS as a result of the Fukushima events. In the event that the NRC identifies information from the Fukushima events that constitutes new and significant information with respect to the environmental impacts of license renewal, the NRC will discuss that information in its site-specific SEISs to the GEIS, as it does with all such new and significant information.

1.10 Changes from the Draft GEIS

In response to public comments on the proposed rule (74 FR 38117, July 21, 2009) and draft GEIS and as a result of information that was unavailable at the time of the issuance of the draft GEIS, the final GEIS contains revisions and new information. Volume 2, Appendix A, Section A.2 presents the comments received during the public comment period on the proposed rule and draft GEIS and NRC's responses to those comments. A brief discussion of the most important changes is provided in this section.

1.10.1 General Overview of Rule-Related Changes

Based on public comments and direction from the Commission, a number of the environmental impact issues identified in Table B-1 of the proposed rule and the associated technical basis for the findings in the draft GEIS were re-evaluated for the final GEIS and rule. Some of these environmental impact issues are discussed in the Section 1.9, "Public Comments on the Draft GEIS." These changes are discussed in detail in Chapter 4 in this final GEIS and are briefly summarized as follows:

- "Air quality (non-attainment and maintenance areas)" issue was changed from a Category 2 to a Category 1 issue and renamed, "Air quality impacts (all plants)."

- “Groundwater and soil contamination,” was changed from a Category 2 to a Category 1 issue and consolidated with “Groundwater use and quality” into a single renamed Category 1 issue, “Groundwater contamination and use.”

- “Thermal impacts on aquatic organisms” issues were reorganized to separate out several Category 1 thermal impact issues (grouped together with a Category 2 thermal impact issue in the proposed rule) to create a new separate combined Category 1 issue, “Infrequently reported thermal impacts (all plants),” which also includes the previously separate “Stimulation of aquatic nuisance species (e.g., shipworms)” Category 1 thermal impact issue. Like Category 1 issues had been grouped together within the larger context of the Category 2 issue in the proposed rule to facilitate the environmental review process consistent with the resource-based approach in this GEIS.

- “Impingement and entrainment of aquatic organisms” issues were reorganized to separate out a single impingement and entrainment Category 1 issue (grouped with other impingement and entrainment issues in the proposed rule) to create a new separate Category 1 issue, “Entrainment of phytoplankton and zooplankton (all plants).” Like impingement and entrainment issues had been grouped together within the larger context of the Category 2 issue, “Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)” in the proposed rule to facilitate the environmental review process consistent with the resource-based approach in this GEIS.

- The NRC revised the Category 1 “Onsite storage of spent nuclear fuel”[(k)] issue to narrow the period of onsite storage to the license renewal term as a result of the 2012 D.C. Circuit decision in *New York v. NRC*, and the Commission’s subsequent direction. As described in section 1.7.2, “Disposition of spent nuclear fuel,” above, pending the issuance of a generic EIS and revised Waste Confidence Decision and Rule, the period of onsite storage of spent nuclear fuel following the permanent shutdown of the power reactor and expiration of the operating license is now excluded from this GEIS issue. As revised, this issue now covers the onsite storage of spent fuel for the term of the extended license only; it remains classified as a Category 1 issue.

- The “Offsite radiological impacts of spent nuclear fuel and high-level waste disposal” issue[(l)] was determined to be a Category 1 issue in the 1996 GEIS, but given the 2012

(k) The issue was named “On-site spent fuel” in the 1996 rule and GEIS.
(l) The issue was named “Offsite radiological impacts (spent fuel and high level waste disposal)” in the 1996 rule and GEIS.

> D.C. Circuit decision in *New York v. NRC*, and the Commission's subsequent direction, the NRC reclassified the issue to uncategorized in the final GEIS. As the NRC has now determined that this issue is uncategorized, pending further action by the Commission to address the issues raised in *New York v. NRC*, an applicant is not required to conduct a plant-specific assessment of the environmental impacts associated with this issue in its environmental report.

As a result, 59 environmental impact issues were determined to be Category 1 and would not require additional plant-specific analysis unless new and significant information is identified during a plant-specific license renewal environmental review that would change the conclusions in the GEIS. Of the remaining 19 issues, 17 were determined to be Category 2, and two are uncategorized. These 78 issues are evaluated in the final GEIS. No environmental issues evaluated in the 1996 GEIS were eliminated, but certain issues have been consolidated or grouped due to the related nature of the impacts.

1.10.2 Greenhouse Gas Emissions and Climate Change

A discussion of greenhouse gas emissions and climate change has been added to the final GEIS.

1.10.3 Miscellaneous Revisions and Editorial Changes

Several sections in the final GEIS were revised to reflect the availability of more recent information or to include corrections, fix erroneous information, improve the presentation, and to make other editorial changes. Sections of the GEIS were also revised in response to the Plain Writing Act of 2010, which directs Federal agencies to write all new publications, forms, and publicly distributed documents in a clear, concise, organized manner and to follow other best practices appropriate to writing for the public. None of these revisions and editorial changes affect the assessment of environmental impacts to the 78 environmental issues addressed in the final GEIS.

1.11 Lessons Learned

As previously discussed, the NRC reviewed and reevaluated the impacts of license renewal on the 92 environmental issues addressed in the 1996 GEIS. Over 40 nuclear plants (70 reactor units) have since undergone license renewal environmental reviews. Lessons learned and knowledge gained from these license renewal environmental reviews have provided a significant source of new information for this GEIS revision.

The purpose of this review and reevaluation was to determine if the findings presented in the 1996 GEIS remain valid. In doing so, the NRC considered the need to modify, add, group, or delete any of the 92 issues in the 1996 GEIS. After this review and reevaluation, the NRC carried forward 78 impact issues for detailed consideration in this GEIS revision. The issues identified in the 1996 GEIS have served to accurately categorize most environmental impacts associated with license renewal, and there have been no cases where new and significant information called into question the original findings of the GEIS. There have been a number of instances where new (but not significant) information was discovered during a license renewal review. In most cases, the new information identified did not fit into one of the 92 environmental issues addressed in the 1996 GEIS but still warranted review in the plant-specific SEIS. For example, the environmental review for license renewal at the D.C. Cook plant in Michigan considered the effects of sanitary sewage lagoons on groundwater quality as a new issue. The review for the Oyster Creek plant considered the effects of a small dam built to impound water for fire-fighting purposes. The license renewal environmental review process established in 10 CFR Part 51 has proven to be robust because it allows new information and lessons learned to be addressed in subsequent plant-specific license renewal environmental reviews.

1.12 New Organization of the GEIS

This GEIS revision adopts the NRC's standard format for EISs as established in 10 CFR Part 51, Subpart A, Appendix A. Consequently, the organizational structure of this GEIS is quite different from that of the 1996 GEIS. The 1996 GEIS presented impacts organized around plant systems (e.g., cooling systems, transmission lines) and activities (e.g., refurbishment). This GEIS takes a more typical NEPA resource-based approach to presenting impacts where all components of the proposed action and alternatives are presented for each resource area. The following list describes the contents of each chapter of GEIS:

- **Chapter 2** presents brief descriptions of the proposed action (including nuclear plant operations, refurbishment, and termination of operations and decommissioning) during the license renewal term and summary of impacts; the no-action alternative; and replacement power alternatives.

- **Chapter 3** presents a general description of the affected environment in the vicinity of operating commercial nuclear power plants in the United States. Included are descriptions of nuclear power plant facilities and operations followed by general descriptions of existing conditions in the following topical areas: (1) land use and visual resources; (2) meteorology, air quality, and noise; (3) geologic environment; (4) water resources (surface water and groundwater resources); (5) ecological resources (terrestrial resources, aquatic resources, special status species and habitats); (6) historic and cultural resources; (7) socioeconomics; (8) human health (radiological and nonradiological hazards); (9) environmental justice; and (10) waste management.

- **Chapter 4** presents the environmental consequences associated with the proposed action (license renewal) and replacement power alternatives (including the effects of construction and operations) on each of the topical areas presented in Chapter 3. Impacts common to all alternatives (including the environmental consequences of fuel cycles and terminating power plant operations), cumulative impacts, and resource commitments associated with the proposed action are also discussed.

- **Chapter 5** presents a list of the preparers of this GEIS, their affiliations, authorship responsibilities, and qualifications.

- **Chapter 6** provides a list of the agencies, organizations, and persons receiving copies of the GEIS.

- **Chapter 7** provides for a glossary of terms used in the GEIS.

1.13 References

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10 CFR Part 54. *Code of Federal Regulations*, Title 10, *Energy*, Part 54, “Requirements for Renewal of Operating Licenses for Nuclear Power Plants.”

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40 CFR Part 98. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 98, "Mandatory Greenhouse Gas Reporting."

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4 Environmental Consequences and Mitigating Actions

4.1 Introduction

The U.S. Nuclear Regulatory Commission (NRC) evaluated the environmental consequences of the proposed action (i.e., license renewal) including the (1) impacts associated with continued operations and refurbishment activities similar to those that have occurred during the current license term; (2) impacts of various alternatives to the proposed action; (3) impacts from the termination of nuclear power plant operations and decommissioning after the license renewal term (with emphasis on the incremental effect caused by an additional 20 years of operation); (4) impacts associated with the uranium fuel cycle; (5) impacts of postulated accidents (design-basis accidents and severe accidents); (6) cumulative impacts of the proposed action; and (7) resource commitments associated with the proposed action, including unavoidable adverse impacts, the relationship between short-term use and long-term productivity, and irreversible and irretrievable commitment of resources.

Contents of Chapter 4

In evaluating impacts for this revision of the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NRC 1996, referred to in this document as the "1996 GEIS"), the NRC used a standard of significance based on the Council on Environmental Quality (CEQ) terminology for "significantly" (see Title 40, Section 1508.27 in the *Code of Federal Regulations* [40 CFR 1508.27]), which considers both "context" and "intensity." The NRC established three significance levels—SMALL, MODERATE, and LARGE—and has used these levels and associated definitions as standard practice in preparing its supplemental environmental impact statements (SEISs) to the GEIS. As indicated in Section 1.5, the definitions of the three significance levels are as follows:

- **SMALL:** Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

- **MODERATE:** Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

- **LARGE:** Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

These levels are used for describing the impacts of most aspects of the proposed action as well as the impacts of alternatives to the proposed action. Resource-specific definitions are provided where applicable.

4.1.1 Environmental Consequences of the Proposed Action

As described in Section 2.1, a number of activities associated with the proposed action could have environmental consequences. The proposed action includes the activities associated with normal operations during the license renewal term, including (1) plant operation, (2) activities needed to support operations and meet infrastructure requirements (e.g., road improvements, new parking lots, waste storage facilities, and new ancillary buildings), and (3) refurbishment actions needed to replace and/or repair critical portions of reactor systems.

The assessment includes a determination of the magnitude of the impact (SMALL, MODERATE, or LARGE, as defined above) and whether or not the analysis of the environmental issue could be applied to all or a category of plants. Issues are assigned a Category 1 or a Category 2 designation as follows:

Category 1 issues are those that meet all of the following criteria:

- The environmental impacts associated with the issue were determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

- A single significance level (i.e., SMALL, MODERATE, or LARGE) was assigned to the impacts (except for offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste).

- The mitigation of adverse impacts associated with the issue was considered in the analysis, and it was determined that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required in future supplemental EISs (SEISs) unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria of Category 1 and for which, therefore, an additional plant-specific review is required.

A total of 78 impact issues that are related to the proposed action were identified (summarized in Table 2.1-1). For each potential environmental impact issue identified, the GEIS revision (1) describes the nuclear power plant activity that could affect the resource, (2) identifies the resource that is affected, (3) evaluates past license renewal reviews and other available information, (4) assesses the nature and magnitude of the environmental impact on the affected resource, (5) characterizes the significance of the effect, (6) determines whether the results of the analysis apply to all nuclear power plants (i.e., whether the impact issue is Category 1 or Category 2), and (7) considers additional mitigation measures for adverse impacts. In cases for which the issue differs from that presented in the 1996 GEIS, the rationale for the new treatment is presented.

4.1.2 Environmental Consequences of Continued Operations and Refurbishment Activities during the License Renewal Term

> In most cases, the impacts of continued operations and refurbishment activities during the license renewal term are similar to the impacts that have resulted from the operation of licensed nuclear power plants during the current license term.

The activities that would occur during normal operations of the license renewal term and that are thus the subject of this evaluation are discussed in Section 2.1. It is important to note that the impacts of the original construction of the nuclear power plants and past operational impacts are not the focus of this evaluation of environmental consequences. Both the impacts of original construction and the impacts of past operations have affected and, in many cases, established the current conditions at each plant and vicinity. These conditions serve as the baseline for the impact analyses presented in this section. Past impacts are presented in the description of the affected environment in Chapter 3. In these cases, the impacts of continued operations and refurbishment activities during the license renewal term are similar to the impacts that have resulted from the operation of licensed nuclear power plants during the current license term. In most cases, impacts of the proposed action would not represent a change from current conditions and are considered SMALL. In other cases, the proposed action could result in a change from current conditions, and the impacts could be considered MODERATE or LARGE.

A total of 78 impact issues (including 5 issues related to waste management at both nuclear power plants and other nuclear fuel cycle facilities) that are related to continued operations and refurbishment activities during the license renewal term were identified and evaluated; they are summarized in Table 2.1-1. This revised GEIS provides the technical basis for the issues presented in Table B-1 in Appendix B, Subpart A, of 10 CFR Part 51. The identified impact issues are discussed by resource topic in the remainder of this section. The assessment approaches specific to each resource area are described in Appendix D.

4.1.3 Environmental Consequences of the No-Action Alternative

The no-action alternative represents a decision by the NRC not to issue a renewed operating license. If a license is not renewed, the licensee would have to shut the plant down. At some point in time, all plants eventually would be required to shut down and undergo decommissioning. Under the no-action alternative, these eventualities would occur sooner than if the NRC issued a renewed license.

Denying license renewal and ceasing operation under the no-action alternative may lead to a variety of potential outcomes, but these are essentially the same as the ones that would eventually occur once plant operations ceased after license renewal (see Section 4.12.2 for a discussion of these effects). Reactor shutdown would result in a net reduction in power production capacity. The power not generated by the nuclear plant during a license renewal term would likely be replaced by (1) generating alternatives other than the nuclear power plant, (2) demand-side management, (3) power purchased from other electricity providers, or (4) some combination of these options. Note that NRC's consideration of the no-action alternative does not involve the determination of whether any power is needed or should be generated. The decision to generate power and the determination of how much power is needed are at the discretion of State, Federal (non-NRC), and utility officials.

4.1.4 Environmental Consequences of Replacement Power Alternatives

Replacement power alternatives consider the potential environmental impacts from the construction and operation of alternative power generating technologies (including a new nuclear reactor) that could replace the power from an existing nuclear power plant. Each resource area in this chapter assesses the environmental effects of constructing and operating various replacement power alternatives. Alternatives were selected on the basis of reviews of energy technologies that are either currently commercially viable on a utility scale and operational prior to the expiration of a reactor's operating license or can be expected to become commercially viable on a utility scale and operational prior to the expiration of a reactor's operating license. Other energy technologies that hold promise for becoming part of a bulk electricity portfolio sometime in the future are identified but not evaluated in detail. Should the need arise to replace the electrical power generating capacity of a reactor, either because its operating license will not be renewed or because of changes in strategies to meet changing regional or local demand, the necessary replacement power is likely to be provided by a suite or portfolio of electrical energy producing technologies, including, perhaps, expansions of the capacities of one or more existing power-generating facilities within the region. The number of possible combinations of energy producing technologies to replace lost electrical power generating capacity is quite large. An evaluation of even a small fraction of these combinations would not significantly advance the knowledge base supporting the license renewal decision. Consequently, individual technologies rather than combinations are evaluated as replacement power alternatives in this GEIS. Data on commercial products or services are included for information purposes only. No endorsement is implied. The NRC does not engage in energy-planning decisions and makes no judgment as to which of the replacement power alternatives would be chosen in any given case.

In addition to the installation of electrical energy producing technologies, replacement power could also be provided by importing power over the bulk electricity grid. Power replaced through energy purchases would likely have similar characteristics to some of the replacement power alternatives being considered, and would be dependent on available energy sources at the time of the purchase. At the time of publication, coal, natural gas, and nuclear-fueled power plants are the most-prevalent sources of purchased replacement power, though an increasing number of renewable power sources are emerging. As such, the effects of purchased power are likely to be similar to the effects of operating a combination of electrical energy producing technologies or similar to the fossil or nuclear-fueled alternatives. Impacts overall are likely to be lower for purchased power (if existing power generation and transmission capacity is also available) since no construction is necessary. On the other hand, since existing plants are likely to have less-stringent emissions controls, operational impacts to air quality and human health may be slightly greater for purchased power than for new construction.

4.1.5 Environmental Consequences of Terminating Nuclear Power Plant Operations and Decommissioning

All operating nuclear power plants will terminate operations and be decommissioned at some point after the end of their operating licenses or after a decision is made to cease operations. License renewal could potentially delay this eventuality for an additional 20 years beyond the current license period. The impacts of decommissioning nuclear plants were evaluated in the *Generic Environmental Impact Statement for Decommissioning Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors*, NUREG-0586 (NRC 2002a). The effects of license renewal on the impacts of terminating nuclear power plant operations and decommissioning are considered a single environmental issue. Because the impacts are expected to be SMALL at all plants and for all environmental resources, it is considered a Category 1 issue. The impacts of terminating nuclear power plant operations and decommissioning for each resource area are discussed in Section 4.12.2.

4.2 Land Use and Visual Resources

4.2.1 Environmental Consequences of the Proposed Action—Continued Operations and Refurbishment Activities

Since September 11, 2001, changes in onsite land use have occurred at nuclear power plants across the nation, with increased restrictions on site access and changes in barricades and landscaping to enhance security. Generally, land use conditions are expected to continue unchanged until plant decommissioning. Similarly, the use of transmission line ROWs is projected to continue with few, if any, changes in restrictions and easements.

In addition, the presence and visual profiles of operating nuclear power plants and transmission lines have been well established during the current licensing term. These conditions would remain unchanged during the 20-year license renewal term.

4.2.1.1 Land Use

In the 1996 GEIS, the impacts of nuclear power plant operations on onsite land use, power line right of way, and offsite land use (license renewal term and refurbishment) were evaluated separately. While it was concluded that impacts to onsite land use and power line right of ways would be small at all plants, anticipated changes in population and tax revenues attributed to license renewal and power plant refurbishment were predicted to have SMALL to MODERATE impacts on offsite land use. Subsequent license renewal reviews have shown, however, that license renewal and power plant refurbishment have had little or no effect on offsite land use.

Land use impact issues evaluated for this GEIS revision include the impacts of continued plant operations and refurbishment activities on (1) onsite land use (evaluated in the 1996 GEIS); (2) offsite land use (consolidation and reclassification of two 1996 GEIS issues: (1) offsite land use (refurbishment) and (2) offsite land use (license renewal term)); and (3) offsite land use in transmission line ROWs (issue was renamed from the 1996 GEIS issue, “Power line right-of-ways”).

Onsite Land Use

Operational activities at a nuclear power plant during the license renewal term would be similar to those occurring during the current license term. Generally, onsite land use conditions would remain unchanged. However, additional spent nuclear fuel and low-level radioactive waste generated during the license renewal term could require the construction of new or expansion of existing onsite storage facilities. Should additional storage facilities be required, this action would be addressed in separate license reviews conducted by the NRC. The NRC has not identified any information or situations during previous license renewal reviews that would alter the conclusion that impacts from continued plant operations and refurbishment would be SMALL for all commercial nuclear power plants. Refurbishment activities, such as steam generator and vessel head replacement, have not permanently changed onsite land use conditions.

On the basis of these considerations, the NRC concludes that the impact of continued plant operations during the license renewal term and refurbishment on onsite land use would be SMALL for all nuclear plants and remains a Category 1 issue.

Offsite Land Use

The impacts of continued plant operations during the license renewal term and refurbishment on offsite land use were evaluated separately in the 1996 GEIS. It was predicted that impacts associated with refurbishment and changes in population and tax revenue on offsite land use could range from SMALL to MODERATE. Subsequent license renewal reviews, however, have shown no power plant-related population changes or significant tax revenue changes due to license renewal. Non-outage employment levels at nuclear power plants have remained relatively unchanged or have decreased. With no increase in the number of workers, there has been no increase in housing, infrastructure, or demand for services beyond what has already occurred. Operational activities during the license renewal term would be similar to those occurring during the current license term and would not affect offsite land use beyond what has already been affected. The NRC has not identified any information or situations, including low population areas or population and tax revenue changes resulting from license renewal that would alter the conclusion that impacts on offsite land use would be SMALL for all nuclear power plants.

For plants that have the potential to impact a coastal zone or coastal watershed, as defined by each State participating in the National Coastal Zone Management Program, applicants for license renewal must submit to the affected State a certification that the proposed license renewal is consistent with the State Coastal Zone Management Program. Applicants must coordinate with the State agency that manages the State Coastal Zone Management Program to obtain a determination that the proposed nuclear plant license renewal would be consistent with the State program. Consistency with State Coastal Zone Management Programs assures that impacts in State coastal zones will be SMALL.

On the basis of these considerations, the NRC concludes that the impact of continued plant operations during the license renewal term and refurbishment on offsite land use would be SMALL at all plants and is considered a Category 1 issue.

Offsite Land Use in Transmission Line ROWs

As previously discussed in Section 3.1.6.5, in most cases, transmission lines originating at power plant substations are no longer owned or managed by nuclear power plant licensees. Accordingly, only those transmission lines that connect the plant to the switchyard where electricity is fed into the regional power distribution system (encompassing those lines that connect the plant to the first substation of the regional electric power grid) and power lines that feed the plant from the grid during outages are considered within the scope of license renewal environmental reviews. Operational activities in offsite transmission line ROWs, within this scope of review, during the license renewal term, would be similar to those occurring during the current license term and would not affect offsite land use in transmission line ROWs beyond what has already been affected.

Certain land use activity in the ROW is usually restricted. Land cover is generally managed through a variety of maintenance procedures so that vegetation growth and building construction do not interfere with power line operation and access. Land use within ROWs are limited to activities that do not endanger power line operation; these include recreation, off-road vehicle use, grazing, agricultural cultivation, irrigation, roads, environmental conservation, and wildlife areas.

Impacts on crop production that may have been caused by transmission line interference with aerial spraying have been reported by one field study of cotton, rice, and soybean fields crossed by a 500-kV line in eastern Arkansas (Parsch and Norman 1986). This study hypothesized that crop yields could be reduced either by electromagnetic fields (EMFs) or by inadequate aerial spraying directly under the power lines. Only cotton yields were found to be reduced; 15 percent less lint was produced under the lines than 150 ft (46 m) from the lines. The resulting loss of income from cotton was estimated as $85.25 per year for an 1,100-ft (335-m) span of the lines, based on a 15 percent yield reduction and an average lint yield of 480 lb/acre (538 kg/hectare). The field sampling and statistical analyses were extensive; the observed yield reduction appeared to be real rather than a sampling error. However, the study could not determine whether the EMF or line interference with aerial spraying caused the yield reduction.

Transmission lines do not preclude the use of the land for farming or environmental and recreational use. Transmission lines connecting nuclear power plants to the electrical grid are no different from transmission lines connecting any other power plant.

The impact of transmission lines on offsite land use during the license renewal term was considered to be SMALL for all plants and was designated as a Category 1 issue in the 1996 GEIS. No new information that would alter that conclusion has been identified in subsequent license renewal reviews.

On the basis of these considerations, the NRC concludes that the impact of transmission line ROWs on offsite land use during the license renewal term would be SMALL for all plants and remains a Category 1 issue.

4.2.1.2 Visual Resources

In the 1996 GEIS, the NRC considered the visual resource impacts of continued plant operations, refurbishment, and transmission lines separately as follows: (1) aesthetic impacts (refurbishment); (2) aesthetic impacts (license renewal term); and (3) aesthetic impacts of transmission lines (license renewal term). Subsequent license renewal environmental reviews conducted by the NRC have shown that nuclear power plants and transmission lines have not changed in appearance significantly over time, so aesthetic impacts are not anticipated. The three issues identified in the 1996 GEIS were combined and are evaluated as a single issue.

Aesthetic Impacts

As previously discussed, the NRC considered the impacts of continued plant operations during the license renewal term and refurbishment on visual resources separately in the 1996 GEIS. The NRC concluded that for both issues the impacts on visual resources would be SMALL for all plants and both were determined to be Category 1 issues, because the existing visual profiles of nuclear power plants were not expected to change during the license renewal term. A case study performed for the 1996 GEIS found a limited number of situations where nuclear power plants had a negative effect on visual resources. Negative perceptions were based on aesthetic considerations (for instance, the plant is out of character or scale with the community or the viewshed), physical environmental concerns, safety and perceived risk issues, an anti-plant attitude, or an anti-nuclear orientation. It is believed that these negative perceptions would persist regardless of mitigation measures. Subsequent license renewal reviews have not revealed any new information that would change this perception.

In addition, the visual appearance of transmission lines is not expected to change during the license renewal term. After the containment building and cooling towers, transmission line towers are probably the most frequently observed structure associated with nuclear power plants. Transmission lines from nuclear power plants are generally indistinguishable from those from other power plants. Since electrical transmission lines are common throughout the United States, they are generally perceived with less prejudice than the nuclear power plant itself. Also, the visual impact of transmission lines tends to wear off when viewed repeatedly. Replacing or moving towers or burying cables to reduce the visual impact would be impractical from both an efficiency and cost-benefit perspective. The impact of transmission lines during the license renewal term on visual resources was considered to be SMALL for all plants and designated as a Category 1 issue in the 1996 GEIS. No new information that would alter that conclusion has been identified in subsequent license renewal environmental reviews.

On the basis of these considerations, the NRC concludes that the aesthetic impacts of continued plant operations during the license renewal term, refurbishment, and transmission lines, within this scope of review, on visual resources would be SMALL for all plants and remains a Category 1 issue.

4.2.2 Environmental Consequences of Alternatives to the Proposed Action

Construction—Construction of a new power plant would involve the permanent commitment of land for the power plant, plant intake and discharge structures, water treatment facilities, and cooling towers. Other construction-related land use impacts would include land clearing, excavations, drilling of monitoring wells, and the installation of temporary support facilities. Material laydown areas and onsite concrete batch plants would also represent additional temporary land use and visual impacts. These would be removed after the power plant is completed. Depending on location, construction of electrical substation, switchyards, transmission lines, railroad spurs, access roads may also be required. Some of these facilities could affect offsite land use.

Construction at an existing nuclear power plant site or brownfield site would have less of an impact on land use and visual resources than a greenfield site. Construction at an existing nuclear power plant site would have the least impact on land use, because the plant could make use of existing intake and discharge structures, substations, transmission lines, office buildings, parking lots, and access roads. Constructing a power plant at a greenfield site would remove land from other productive uses such as agriculture. It could convert potential prime farmland to industrial use. In addition, construction at a greenfield site would have a more dramatic impact on visual resources, since the industrial power plant would likely be significantly different from the surrounding landscape. Constructing at a brownfield site would have less of an impact on the land use than a greenfield site.

The increase in traffic to and from the construction site could require changes to existing transportation infrastructure and traffic patterns resulting in offsite land use impacts and visual impacts. These impacts would cease at the end of construction.

Operations—Land would be in use throughout the period of power plant operation. Visual resources would also be affected. Visual impacts would be similar to other industrial activities at an existing nuclear power plant site or brownfield site. However, the height of new buildings structures as well as transmission line, meteorological, and cooling towers could add to the visual impact. Condensate plumes during plant operations may be visible for some distance during certain weather conditions.

4.2.2.1 Fossil Energy Alternatives

Construction and Operations—Impacts on land use from constructing coal- or natural gas-fired power plants would be similar. However, a coal-fired power plant would need more land than a natural gas-fired plant due to the need for coal fuel delivery and waste storage facilities. As a result, the coal-fired power plant would also have a higher visual impact.

4.2.2.2 New Nuclear Alternatives

Construction and Operations—Land would be required for the construction of spent nuclear fuel and low-level radioactive waste storage facilities. The appearance of the reactor containment and turbine buildings would add to the visual impact.

4.2.2.3 Renewable Alternatives

Construction—Land requirements for renewable energy facilities vary greatly. Biomass fueled energy facilities with utility-scale capacities could require at least 300 ac (122 ha). Flat plate solar photovoltaic systems would require approximately 6.2 ac (2.5 ha)/MW; however, improvements in photovoltaic cell efficiency could reduce the amount of land required to 0.68 ac (0.28 ha)/MW by 2030. Solar thermal facilities with concentrators would require substantial land area. Projected land requirements for advanced power tower facilities generating 200 MWe in the year 2030 would be 612 ac (247 ha). Given the expected capacity factor of advanced power tower facilities, the land requirements equate to 1.1×10^{-3} ha/MWh/yr (EERE 1997). Land area required for an advanced solar power trough facility operating in 2030 with a rated capacity of 320 MW would be 792 ac (320 ha) (EERE 1997).

Wind energy facilities would require approximately 0.3 ac (0.12 ha)/MW. Utility-scale wind farms would require relatively large areas. However, unlike solar technologies, once construction is completed, land areas between the turbines can be put to other beneficial (nonintrusive) use. Substantially lesser amounts of land area would be required for geothermal facilities (estimated at 173 ac [70 ha] for a 49 MW facility) (BLM 1999), and very small amounts of land (for cable landings and substations, estimated at 100 ac [40.4 ha] for utility-scale offshore energy facilities) would be required for offshore wind and current facilities.

For renewable energy technologies that utilize combustion and/or steam cycles, the appearance of buildings, height and prominence of smokestacks, and condensate plumes, would have a visual impact.

Operations—The operational impacts of alternative energy technologies on land use and visual resources are presented in the following subsections.

Hydroelectric Energy Sources

Hydroelectric dams and reservoirs capable of generating utility-scale power would be substantial in scale and prominence and have a visual impact. Large dams that also serve as flood control could significantly affect land use patterns upstream and downstream beyond the decommissioning of the facility.

Geothermal

Geothermal facilities would be less prominent, typically located in remote areas and may generate a steam plume that is visible from long distances. Visual resources would be affected by wellheads, exposed transfer piping, and power plant structures, and could have a dramatic impact on a remote area. The intermittent creation of steam condensate plumes would be visible from great distances.

Wind

A relatively large area of land would be required for wind energy; however, only about 5 to 10 percent of the land area would be utilized by turbines, power collection and conditioning systems, and other support facilities. Land affected by the installation of buried power and communication cables interconnecting each turbine with a power substation would be minimally intrusive. Wind farms, although less complex than combustion-based facilities in their visual appearance, would have a visual impact due to the height of the turbines. Offshore wind farms could be sufficiently distant from the shore to attenuate most, if not all, of the visual impacts on onshore observers.

Biomass

The physical appearance of a biomass fuel-fired energy facility would be similar to that of a fossil fuel fired facility. The industrial footprint would be less. Additional land would be required, however, for growing biomass crops.

Municipal Solid Waste, Refuse-Derived Fuel, and Landfill Gas

The physical appearance of a municipal solid waste, refuse-derived and landfill gas-fired energy facility would be similar to that of a fossil fuel fired facility, but the amount of land needed for the energy production facilities would be less. Some additional land would be required, however, for fuel handling facilities (e.g., storage piles, hammermills, grinders, bucket conveyors, blowers, and pneumatic conveyance systems). Buildings, smokestacks, cooling towers, and condensate plumes would have a visual impact, but would be comparable to a fossil fuel-fired facility.

Solar Thermal

Land would be required for the powerblock (steam cycle, turbine/generator building, substation, cooling towers, condensate plume, and support equipment). Visual impacts would occur if a power tower technology is employed as well as the array of solar collectors.

Solar Photovoltaic

Utility-scale facility would require a very large area of land. Visual resources would be affected by the size of the facility.

Ocean Wave and Current

Land use would be only slightly affected by land-based support systems (cable landing, substation, and warehouse and repair facility); existing piers and docks are expected to be sufficient to support the offshore facility during operation. Above-water components are expected to be relatively inconspicuous, even when equipped with marker lights; their relatively small height above the water, their distance from shore, and the curvature of the earth may serve to partially or completely conceal them from onshore observers.

4.3 Air Quality and Noise

4.3.1 Environmental Consequences of the Proposed Action—Continued Operations and Refurbishment Activities

Ambient air quality and noise conditions at all nuclear power plants and associated transmission lines have been well established during the current licensing term. Notwithstanding significant changes to the nature and type of industrial activities in the area, these conditions are expected to remain unchanged during the 20-year license renewal term.

The focus of this section is the impacts of continued operations and refurbishment activities during the license renewal term on air quality and noise. Refurbishment and associated construction activities can affect air quality (e.g., fugitive dust, vehicle and equipment exhaust emissions, and automobile exhaust from commuter traffic). Baseline meteorological, climatological, and ambient air quality and noise conditions at operating plants are discussed in Sections 3.3.1 and 3.3.2, respectively. License renewal is expected to result in a continuation of similar conditions for an extended period commensurate with the license renewal term, typically 20 years. As a result, the criteria air pollutants emitted and the noise generated during normal continued plant operations over the license renewal term are not expected to change substantially and thus should remain SMALL.

4.3.1.1 Air Quality

Two issues related to impacts on air quality during the license renewal term are considered in this section:

- Air quality impacts (all plants); issue encompasses impacts of continued operations (not considered in the 1996 GEIS) and refurbishment activities on air quality, including nonattainment or maintenance area conformity (issue was modified, reclassified, and renamed from the 1996 GEIS); and

- Air quality effects of transmission lines. This issue was evaluated in the 1996 GEIS.

Air Quality Impacts (All Plants)

Continued Operations—The impact of continued plant operations during the license renewal term on air quality was not identified as an issue in the 1996 GEIS. It is evaluated here because of the potential for air quality to be affected by the operations of fossil-fuel-fired equipment needed for normal operations and by the operations of cooling towers in plants that use a closed-cycle cooling system. These potential impacts are discussed below.

Impacts on air quality during normal plant operations can result from operations of fossil-fuel-fired equipment needed for various plant functions (see Section 3.3.2). Each licensed plant typically employs emergency diesel generators for use as a backup power source. Emergency diesel generators and fire pumps typically require State or local operating permits. These generators provide a standby source of electric power for essential equipment required during plant upset or an emergency event. They also provide for safe reactor shutdown and for the maintenance of safe conditions at the power station during such an event. These diesel generators are typically tested once a month with several test burns of various durations (e.g., 1 to several hours). In addition to these maintenance tests, longer-running endurance tests are also typically conducted at each plant. Each generator is typically tested for 24 hours on a staggered test schedule (e.g., once every refueling outage). Plants with nonelectric fire pumps, typically also diesel-fired, usually employ test protocols identical or similar to those used for emergency generators. Maintenance procedures during these tests would include, for example, checks for leaks of lubricating oil or fuel from equipment, and pumps would be replaced as required. Most State air pollution regulations provide exemptions for air pollution sources that are not routinely operated, which can be defined as sources with insignificant activity meeting specified operating criteria (e.g., so many hours of continuous operation over specified periods or so many hours of operation per year).

In addition to the emergency diesel generators, fossil fuel (i.e., diesel-, oil-, or natural-gas-fired) boilers are used primarily for evaporator heating, plant space heating, and/or feed water purification. These units typically operate at a variable load on a continuous basis throughout the year unless end use is restricted to one application, such as space heating. Air emissions include carbon monoxide (CO), nitrogen oxides (NO_x), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), particulate matter (PM), and volatile organic compounds (VOCs) for diesel-, natural-gas-, and oil-fired units. Natural-gas-fired units emit only trace amounts of VOCs and PM that has an aerodynamic diameter of 10 μm or less (PM_{10}). The utility boilers at commercial plants are relatively small when compared with most industrial boilers and are typically regulated through State-level operating permits.

The potential impact from emergency generators and boilers on air quality would be expected to be SMALL for all plants, and, given the infrequency and short duration of maintenance testing, it would not be an air quality concern even at those plants located in or adjacent to nonattainment areas. The locations of the currently designated nonattainment areas near nuclear plants are shown in Section 3.3.2.

As discussed in Section 3.3, cooling tower drift can increase downwind PM concentrations, impair visibility, ice roadways, cause drift deposition, and damage vegetation and painted surfaces. There are currently 24 licensed nuclear power plants that use wet cooling towers in closed-cycle cooling systems. Most of the plants use two or more towers for reactor heat removal. Of the 47 operating towers, 24 are natural draft cooling towers and 23 are mechanical draft cooling towers. There are currently no dry or hybrid (combinations incorporating elements of both dry and wet design) systems being used at operating nuclear plants. Only 1 of the 47 towers (a natural draft cooling tower at the Hope Creek plant in New Jersey) is operating at a plant that uses high-salinity water for cooling system makeup. An air quality impact analysis performed in support of an extended power uprate request for Hope Creek assessed emissions related to cooling tower drift droplets and PM for this worst-case situation and found that the impacts of cooling tower operations on air quality were small, as summarized in Section 3.3.2.

Thus, although there is the potential for some air quality impacts to occur as a result of equipment and cooling tower operations, even in the worst-case situation (Hope Creek), the impacts have been small, and licensees would be required to operate within State permit requirements.

Refurbishment Activities—Potential sources of impacts on air quality during refurbishment activities associated with continued operations during the license renewal term include (1) fugitive dust from site excavation and grading and (2) emissions from motorized equipment, construction vehicles, and workers' vehicles. Some refurbishment activities would be performed on equipment inside existing buildings and would not generate air emissions.

With application of adequate controls or mitigation measures and best practices, the air quality impacts from these air pollution sources would be small and of relatively short duration. The disturbed area for refurbishment actions, if required, is expected to be 10 ac (4 ha) or less, based on assumptions from the 1996 GEIS. During site excavation and grading, some PM in the form of fugitive dust would be released into the atmosphere. Because of the (1) small size of the disturbed area, (2) relatively short construction period, (3) availability of paved roadways at existing facilities, and (4) use of best management practices (BMPs) (such as watering, chemical stabilization, and seeding), fugitive dust resulting from these construction activities would likely be minimal.

Construction vehicles and other motorized equipment would generate exhaust emissions that include small amounts of CO, NO_x, VOCs, and PM. These emissions would be temporary (restricted to the construction period) and localized (occurring only in the immediate vicinity of construction areas). Emissions impacts from construction equipment and vehicles (e.g., CO, hydrocarbons, and PM from use of diesel fuels) and from fugitive dust emissions from ground-clearing and grading activities could be SMALL or MODERATE. For refurbishment occurring in geographical areas with poor or marginal air quality, the emissions generated from these activities could be cause for concern in a few cases (e.g., building demolition, debris removal, and new construction). However, the 1990 Clean Air Act Amendments include a provision that no Federal agency shall support any activity that does not conform to a State Implementation Plan designed to achieve the National Ambient Air Quality Standards (NAAQS) for criteria pollutants (sulfur dioxide [SO_2], nitrogen dioxide [NO_2], CO, ozone [O_3,], lead [Pb], PM_{10}, and PM with a mean aerodynamic diameter of 2.5 μm or less [$PM_{2.5}$]).

On April 5, 2010, the U.S. Environmental Protection Agency (EPA) issued its 40 CFR Part 51 and 93 revisions to the General Conformity Regulations in the *Federal Register* (75 FR 17254) These regulations revised and updated the general conformity regulations published on November 30, 1993, in 58 FR 63214. General conformity requires Federal agencies to ensure that a proposed Federal action in air quality nonattainment or maintenance areas conforms to the applicable State Implementation Plan. A conformity analysis must be completed before the action is taken. A conformity analysis begins with an applicability analysis to determine whether the action is exempt or has total net direct and indirect emissions below the *de minimis* levels. The *de minimis* emission levels (40 CFR 93.153(b)) serve as screening values to determine whether a conformity determination must be undertaken for a proposed Federal action. The applicability analysis must be documented. If conformity applies, the agency must prepare a written conformity analysis and determination for each pollutant for which the emissions caused by a proposed Federal action would exceed the *de minimis* levels. An area is designated as nonattainment for a criteria pollutant if it does not meet NAAQS for the pollutant. A maintenance area is one that a State has redesignated from nonattainment to attainment. The current nationwide designations of nonattainment and maintenance areas are identified in Section 3.3.2.

The *de minimis* levels for air emissions vary depending on air quality conditions in the area where the plant is located. In most cases, the *de minimis* levels are established at 100 tons per year. Exceptions include:

- NO_x or VOC emissions of 10, 25, and 50 tons per year in extreme, severe, and serious ozone nonattainment areas, respectively;

- VOC emissions of 50 tons per year in ozone nonattainment areas inside an ozone transport region stretching from Virginia to Maine;

- PM_{10} emissions of 70 tons per year in serious PM_{10} nonattainment areas; and

- Lead emissions of 25 tons per year in lead nonattainment areas.

None of the operating nuclear plants are located in extreme, severe, or serious ozone nonattainment areas; in serious PM_{10} nonattainment areas; or in lead nonattainment areas. Therefore, the *de minimis* levels applied to plants in the nonattainment areas are 100 tons per year for all criteria pollutants except VOC emissions of 50 tons per year for plants within the ozone transport region.

In maintenance areas, the *de minimis* levels are 100 tons per year for all pollutants, except for 50 tons per year for VOCs inside the ozone transport region. The *de minimis* levels of 25 tons per year apply in maintenance areas, but no plants are located in these areas.

In addition to the above, *de minimis* levels of 100 tons per year applies to SO_2 and NO_x emissions in $PM_{2.5}$ nonattainment and maintenance areas unless NO_x is determined not to be a significant $PM_{2.5}$ precursor. Levels of 100 tons per year may apply to emissions of VOCs and ammonia if either is determined to be a significant precursor. The regulations require that direct construction emissions including construction vehicle and equipment exhaust and fugitive dust and indirect emissions such as those from worker and delivery vehicles be included in the conformity analysis.

Emissions from construction equipment and vehicles are expected to be small for anticipated refurbishment projects on the basis of activities that have occurred to date; however, larger projects may require a sizeable workforce that could contribute vehicle exhaust emissions that could exceed the *de minimis* thresholds for CO, NO_x, and VOCs (the latter two contribute to the formation of O_3) in nonattainment and maintenance areas. In addition, the amount of fugitive dust generated by dust resuspension from larger projects involving construction vehicle use onsite or vehicle use in the vicinity of construction activities may approach or exceed the threshold for PM_{10} and $PM_{2.5}$ in nonattainment and maintenance areas. Dust suppression measures could be implemented in areas of concern. In summary, emissions from equipment and vehicle exhaust and fugitive dust could result in impacts, but could be mitigated through appropriate fugitive dust control measures.

In the 1996 GEIS, the NRC concluded that the impacts from plant refurbishment associated with license renewal on air quality could range from SMALL to LARGE, although these impacts were expected to be SMALL for most plants. However, findings from license renewal SEISs published since the 1996 GEIS have shown that refurbishment activities, such as steam generator and vessel head replacement, have not required the large numbers of workers and months of time, as well as the degree of land disturbance, that was conservatively estimated in the 1996 GEIS. Presumed air pollutant emissions, including levels of fugitive dust, have therefore not been realized. The NRC concludes that the impact of refurbishment activities on air quality during the license renewal term would be SMALL for most plants, but could be cause for concern at plants located in or near air quality nonattainment or maintenance areas, depending on the nature of the planned activity. Still, the impacts would be temporary and cease once projects were completed and implementation of BMPs including fugitive dust controls and the imposition of new and/or revised conditions in State and local air emissions permits would ensure conformance with applicable State or Tribal Implementation Plans.

On the basis of these considerations, the NRC concludes that the air quality impact of continued nuclear plant operations during the license renewal term and refurbishment would be SMALL for all plants, and that the impacts of license renewal on air quality should be considered a Category 1 issue.

Air Quality Effects of Transmission Lines

Small amounts of ozone and substantially smaller amounts of oxides of nitrogen are produced by transmission lines during corona, a phenomenon that occurs when air ionizes near isolated irregularities on the conductor surface such as abrasions, dust particles, raindrops, and insects. Several studies have quantified the amount of ozone generated and concluded that the amount produced by even the largest lines in operation (765 kilovolt [kV]) is insignificant (SNYPSC 1978; Scott-Walton et al. 1979; Janes 1980; Varfalvy et al. 1985). Monitoring of ozone levels for two years near a Bonneville Power Administration 1,200-kV prototype line revealed no increase in ambient ozone levels caused by the line (Bracken and Gabriel 1981; Lee et al. 1989). Ozone concentrations generated by transmission lines are therefore too low to cause any significant effects. The minute amounts of oxides of nitrogen produced are similarly insignificant. A finding of SMALL significance for transmission lines, within this scope of review (see Sections 3.1.1 and 3.1.6.5 in this GEIS), is supported by the evidence that production of ozone and oxides of nitrogen are insignificant and does not measurably contribute to ambient levels of those gases. Potential mitigation measures (e.g., burying transmission lines) would be very costly and would not be warranted. This is a Category 1 issue.

4.3.1.2 Noise

One issue related to noise impacts during the license renewal term and refurbishment is considered in this section:

- Noise impacts of continued operations and refurbishment activities. This issue was evaluated in the 1996 GEIS.

Noise Impacts

Noise from nuclear plant operations can often be detected offsite relatively close to the plant site boundary. Sources of noise and the relative magnitude of impacts during normal nuclear power plant operations are discussed in Section 3.3.3. Major sources of noise at operating nuclear power plants are cooling towers, turbines, transformers, large pumps, and cooling water system motors. Nuclear plant operations have not changed appreciably with time, and no change in noise levels or noise-related impacts are expected during the license renewal term. Since no change is expected in the amount of noise generated during the license renewal term, the only issue of concern is the number of people now living close to the nuclear power plant who are exposed to operational noise.

Given the industrial nature of the power plant and the number of years of plant operation, noise from a nuclear plant is generally nothing more than a continuous minor nuisance. However, noise levels may sometimes exceed the 55 dBA level that the EPA uses as a threshold level to protect against excess noise during outdoor activities (EPA 1974). However, according to the EPA this threshold does “not constitute a standard, specification, or regulation,” but was intended to provide a basis for State and local governments establishing noise standards. Nevertheless, noise levels at the site boundary are expected to remain well below regulatory standards for offsite residents.

Noise would also be generated by construction-related activities and equipment used during refurbishment. However this noise would occur for relatively short periods of time (several weeks) and is not expected to be distinguishable from other operational noises at the site boundary nor create an adverse impact on nearby residents.

In the 1996 GEIS, the NRC concluded that noise was not a problem at operating plants and was not expected to be a problem at any nuclear plant during the license renewal term. The magnitude of noise impacts was therefore determined to be SMALL for all plants, and the issue was designated as Category 1. No new information altering this conclusion has been identified in subsequent license renewal reviews.

On the basis of these considerations, the NRC concludes that the noise impact of continued nuclear plant operations during the license renewal term and refurbishment would be SMALL for all plants, and remains a Category 1 issue.

4.3.2 Environmental Consequences of Alternatives to the Proposed Action

Construction—Air quality impacts would include criteria pollutants from construction vehicles and equipment and dust from land clearing and grading. VOCs could be released from organic solvents used in cleaning, during the application of protective coatings, and the onsite storage and use of petroleum-based fuels. Construction vehicles and equipment would also generate noise. Impacts, however, would be temporary, and both air quality and noise impacts would return to pre-construction levels after construction was completed.

Air quality and noise impacts from construction activities would be similar whether occurring at a greenfield site, brownfield site, or at an existing nuclear power plant. The impacts would be greatest, however, at a greenfield site because of cleaner ambient air quality and noise conditions, even though greenfield sites may also be found in NAAQS nonattainment areas. Onsite concrete batch plants, if required, would also contribute to construction-related dust and noise.

Operations—Air quality would be affected during operations by cooling tower drift; auxiliary power equipment, building heating, ventilation, and air conditioning (HVAC) systems; and vehicle emissions. Auxiliary power equipment could include standby diesel generators and power systems for emergency power and auxiliary steam.

Ambient noise levels would be affected by cooling towers (water pumps, cascading water, or fans), transformers, turbines, pumps, compressors, loudspeakers, other auxiliary equipment such as standby generators, and vehicles. Air quality and noise impacts would be the greatest at greenfield sites.

4.3.2.1 Fossil Energy Alternatives

Construction—Air quality and noise impacts would be the same as described in Section 4.3.2. The impact analysis for fossil energy alternatives is based on projected impacts of facilities studied by the U.S. Department of Energy's (DOE's) National Energy Technology Laboratory (NETL). Baseline performance and cost data for 12 technologies are presented in a report issued by NETL (NETL 2007).

An independent study conducted by the EPA on some of the technologies in the NETL report provides additional environmental impact data (EPA 2006). However, due to different power plant designs and fuel used in the NETL and EPA studies the data are not directly comparable.

Nevertheless, data from both studies are presented to provide a range of environmental impacts. Most of the data presented in the following sections are extracted from those two reports.

Operations—Fossil fuel power plants can have a significant impact on air quality. The burning of fossil fuels is a major source of criteria pollutants and greenhouse gases, primarily CO_2, as well as other hazardous air pollutants. The exact nature of these pollutants depends on the chemical constituency of the fuel, combustion technology, air pollution control devices, and onsite management of fuel (e.g., coal) and waste material. Sources of noise include coal delivery, coal crushing, and fuel and waste handling activities.

The EPA has identified 13 trace elements likely to be emitted from an integrated gasification combined cycle (IGCC) facility, including arsenic, cadmium, lead, mercury, and selenium. The average concentrations of trace elements emitted in pounds emitted per million Btu input (lb/10^6 Btu) are as follows: antimony (4), arsenic (2.1), beryllium (0.09), cadmium (2.9), chloride (740), chromium (2.7), cobalt (0.57), fluoride (38), lead (2.9), manganese (3.1), mercury (1.7), nickel (3.9), and selenium (2.9) (EPA 2006).

Table 4.3-1 displays some of the anticipated air quality impacts of coal-burning technologies (EPA 2006). Table 4.3-2 shows projected emissions of criteria and hazardous air pollutants from fossil fuel plants (NETL 2007). The values presented in the two tables represent the possible range of operational emissions that could result from fossil-fuel-fired power plants.

Fossil fueled power plants not equipped with carbon capture and storage devices will emit large amounts of CO_2 and lesser amounts of other greenhouse gases. EPA projections of CO_2 emissions from a 500-MW integrated gasification combined cycle facility burning bituminous, sub-bituminous, and lignite coals are 1,441 lb/MWh (or 199 lb/MBtu), 1,541 lb/MWh (208 lb/MBtu), and 1,584 lb/MWh (211 lb/MBtu), respectively (EPA 2006). However, as can be seen from the data presented in Table 4.3-2, CO_2 emissions can be reduced by as much as 90 percent with the installation of carbon capture and storage devices.

4.3.2.2 New Nuclear Alternatives

Construction—Air quality and noise impacts for the construction of a new nuclear power plant would be the same as described in Section 4.3.2.

Operations—An operating nuclear plant would have minor air emissions associated with diesel generators and other small-scale intermittent sources. Air quality and noise impacts would be the same as described in Section 4.3.2.

Table 4.3-1. Projected Air Quality Impacts for Selected Power Production Technologies Burning Various Ranks of Coal[(a)]

Fuel	Technology[(b)]	Projected Air Quality Impacts (lb/MWh)							SO_2 Removal Percent	NO_x Removal Basis[(f)]
		NO_x (NO_2)	SO_2	CO	Particulate[(c)]	VOCs	Lead[(d)]	Mercury[(e)]		
Bituminous coal	IGCC	0.355	0.311	0.217	0.051	–	1.0×10^{-6} to 2.4×10^{-6}	5.50×10^{-6}	99	15 ppmvd @ 15 percent O_2
	Subcritical PC	0.528	0.757	0.880	0.106	0.021	3.40×10^{-5} to 18×10^{-5}	6.69×10^{-6}	98	0.06 lb/MBtu
	Supercritical PC	0.494	0.709	0.824	0.099	0.020	3.18×10^{-5} to 17×10^{-5}	6.26×10^{-6}	98	0.06 lb/MBtu
	Ultra-Supercritical PC	0.442	0.634	0.737	0.088	0.018	2.84×10^{-5} to 15×10^{-5}	5.6×10^{-6}	98	0.06 lb/MBtu
Sub-bituminous coal	IGCC	0.326	0.089	0.222	0.052	–	1.0×10^{-6} to 2.4×10^{-6}	3.11×10^{-6}	97.5	15 ppmvd @ 15 percent O_2
	Subcritical PC	0.543	0.589	0.906	0.109	0.025	18×10^{-5} to 23×10^{-5}	3.80×10^{-6}	87[(g)]	0.06 lb/MBtu
	Supercritical PC	0.500	0.541	0.832	0.100	0.023	16.6×10^{-5} to 21×10^{-5}	3.49×10^{-6}	87[(g)]	0.06 lb/MBtu
	Ultra-supercritical PC	0.450	0.488	0.750	0.090	0.020	15×10^{-5} to 19×10^{-5}	3.15×10^{-6}	87[(g)]	0.06 lb/MBtu
Lignite coal	IGCC	0.375	0.150	0.225	0.053	–	1.0×10^{-6} to 2.4×10^{-6}	5.48×10^{-6}	99	15 ppmvd @ 15 percent O_2
	Subcritical PC	0.568	0.814	0.947	0.114	0.026	18.9×10^{-5} to 24×10^{-5}	6.9×10^{-6}	95.8	0.06 lb/MBtu
	Supercritical PC	0.524	0.751	0.873	0.105	0.024	17.5×10^{-5} to 22×10^{-5}	6.37×10^{-6}	95.8	0.06 lb/MBtu
	Ultra-supercritical PC	0.498	0.714	0.830	0.100	0.022	16.6×10^{-5} to 21×10^{-5}	6.06×10^{-6}	95.8	0.06 lb/MBtu

Footnotes on next page.

Table 4.3–1. (cont.)

(a) Proximate analyses values (weight percent) for bituminous/sub-bituminous/lignite study coals include: weight percent ash: 9.70/4.50/17.92; moisture: 11.12/27.40/31.24; fixed carbon: 44.19/36.70/22.96; volatiles: 34.99/31.40/28.08. Higher heating values (Btu/lb) for study coals are: 11,667/8,800/6,312.

(b) None of the technologies represented in this table is equipped with carbon capture and storage (CCS) capability. The EPA study (EPA 2006) on which data in this table are based included only coal combustion technologies. IGCC = integrated gasification combined cycle. PC = pulverized coal.

(c) Particulate removal is 99.9 percent or greater for IGCC cases and 99.8 percent for bituminous coal, 99.7 percent for sub-bituminous coal, and 99.9 percent for lignite coal in the PC cases. Particulate matter emission rates shown include the overall filterable particulate matter only.

(d) Little empirical evidence exists on the behavior of lead in IGCC facilities. The EPA anticipates that approximately 5 percent of the lead in the input coal will be emitted to the air, while the remaining lead will remain with gasifier slag and other solid wastes generated in other gas cleaning units.

(e) As with lead, the behavior of mercury in IGCC systems is not well understood. It is anticipated that as much as 60 percent of coal-derived mercury will be potentially emitted to the atmosphere; however, fabric filters and scrubbers installed for particulate and SO_2 controls may effectively capture as much as 98 percent of the mercury present in exhaust gases. With the advent of mercury emission regulations and the installation of other devices specifically designed to capture mercury, the EPA expects that a larger fraction of mercury contained in the coal will ultimately be found in solid wastes generated in those mercury capture devices.

(f) A percent removal for NO_x cannot be calculated with a basis (i.e., an uncontrolled unit), for comparison. Also, the PC and IGCC technologies use multiple technologies (e.g., combustion controls, selective catalytic reduction [SCR]) to control NO_x. NO_x emission comparisons are based on emission levels expressed in parts per million volume (dry basis) (ppmvd) at 15 percent oxygen for IGCC and lb/MBtu for PC cases.

(g) A relatively low SO_2 removal efficiency of 87 percent results from a relatively low sulfur content in sub-bituminous coal of only 0.22 percent. Higher removal efficiencies occur with higher sulfur-content coals.

Source: EPA 2006

Table 4.3-2. Performance and Cost Data for Fossil-Fuel-Fired Power Plants That Are Likely Alternatives to Retired Nuclear Reactors

	Integrated Gasification Combined Cycle					
Parameter	**General Electric Energy**		**ConocoPhillips**		**Shell**	
CO_2 capture	No	Yes	No	Yes	No	Yes
Gross power output (kWe)	770,350	744,960	742,510	693,840	748,020	693,555
Auxiliary power requirement (kWe)	130,100	189,285	119,140	175,600	112,170	176,420
Net power output (kWe)	640,250	555,675	623,370	518,240	635,850	517,135
Coal flow rate (lb/hr)	489,634	500,379	463,889	477,855	452,620	473,176
Natural gas flow rate (lb/hr)	NA[(a)]	NA	NA	NA	NA	NA
Higher heating value (HHV) thermal input (kWe)	1,674,044	1,710,780	1,685,023	1,633,771	1,547,493	1,617,772
Net plant HHV efficiency (percent)	38.2	32.5	39.3	31.7	41.1	32.0
Net plant HHV heat rate (Btu/kWh)	8,922	10,505	8,681	10,757	8,304	10,674
CO_2 emissions (lb/hr)	1,123,781	114,476	1,078,144	131,328	1,054,221	103,041
CO_2 emissions (tons/yr) @ CF[(b)]	3,937,728	401,124	3,777,815	460,175	3,693,990	361,056
CO_2 emissions (lb/MBtu)	197	19.6	199	23.6	200	18.7
CO_2 emissions (kg/MWh)[(b)]	662	69.7	659	85.9	639	67.4
CO_2 emissions (lb/MWh)[(b)]	1,469	154	1,452	189	1,409	149
CO_2 emissions (lb/MWh)[(c)]	1,755	206	1,730	253	1,658	199
SO_2 emissions (lb/hr)	73	56	68	48	66	58
SO_2 emissions (tons/yr) @ CF[(b)]	254	196	237	167	230	204
SO_2 emissions (lb/MBtu)	0.012	0.0096	0.0125	0.0085	0.0124	0.0105
SO_2 emissions (kg/MWh)[(c)]	0.0427	0.0341	0.0413	0.0311	0.0398	0.0380
SO_2 emissions (lb/MWh)[(c)]	0.0942	0.0751	0.0909	0.0686	0.0878	0.0837
NO_x emissions (lb/hr)	313	273	321	277	309	269
NO_x emissions (tons/yr) @ CF[(b)]	1,096	955	1,126	972	1,082	944
NO_x emissions (lb/MBtu)	0.055	0.047	0.059	0.050	0.058	0.049
NO_x emissions (kg/MWh)[(c)]	0.184	0.166	0.196	0.181	0.187	0.176
NO_x emissions (lb/MWh)[(c)]	0.406	0.366	0.433	0.400	0.413	0.388
PM emissions (lb/hr)	41	41	38	40	37	39
PM emissions (tons/yr) @ CF[(b)]	142	145	135	139	131	137
PM emissions (lb/MBtu)	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071
PM emissions (kg/MWh)[(c)]	0.024	0.025	0.023	0.026	0.023	0.026
PM emissions (lb/MWh)[(c)]	0.053	0.056	0.052	0.057	0.050	0.057
Hg emissions (lb/hr)	0.0033	0.0033	0.0031	0.0032	0.0030	0.0032
Hg emissions (tons/yr) @ CF[(b)]	0.011	0.012	0.011	0.011	0.011	0.011
Hg emissions (lb/MBtu)	0.571	0.571	0.571	0.571	0.571	0.571
Hg emissions (kg/MWh)[(b)]	1.92×10^{-6}	2.03×10^{-6}	1.89×10^{-6}	2.08×10^{-6}	1.83×10^{-6}	2.08×10^{-6}
Hg emissions (lb/MWh)[(b)]	4.24×10^{-6}	4.48×10^{-6}	4.16×10^{-6}	4.59×10^{-6}	4.03×10^{-6}	4.55×10^{-6}

Table 4.3-2. (cont.)

Parameter	Pulverized Coal Boiler				NGCC	
	PC Subcritical		PC Supercritical		Advanced F Class	
CO_2 capture	No	Yes	No	Yes	No	Yes
Gross power output (kWe)	583,315	679,923	580,260	663,445	570,200	520,090
Auxiliary power requirement (kWe)	32,870	130,310	30,110	117,450	9,840	38,200
Net power output (kWe)	550,445	549,613	550,150	545,995	560,360	481,890
Coal flow rate (lb/hr)	437,699	646,589	411,282	586,627	NA	NA
Natural gas flow rate (lb/hr)	NA	NA	NA	NA	165,182	165,182
HHV thermal input (kWe)	1,496,479	2,210,668	1,406,161	2,005,660	1,103,363	1,103,363
Net plant HHV efficiency (%)	36.8	24.9	39.1	27.2	50.8	43.7
Net plant HHV heat rate (Btu/kWh)	9,276	13,724	8,721	12,534	6,719	7,813
CO_2 emissions (lb/hr)	1,038,110	152,975	975,370	138,681	446,339	44,634
CO_2 emissions (tons/yr) @ CF[(b)]	3,864,884	569,524	3,631,301	516,310	1,661,720	166,172
CO_2 emissions (lb/MBtu)	203	20.3	203	20.3	119	11.9
CO_2 emissions (kg/MWh)[(c)]	807	102	762	94.8	355	38.9
CO_2 emissions (lb/MWh)[(c)]	1,780	225	1,681	209	783	85.8
CO_2 emissions (lb/MWh)[(d)]	1,886	278	1,773	254	797	93
SO_2 emissions (lb/hr)	433	Negligible	407	Negligible	Negligible	Negligible
SO_2 emissions (tons/yr) @ CF[(b)]	1,613	Negligible	1,514	Negligible	Negligible	Negligible
SO_2 emissions (lb/MBtu)	0.0848	Negligible	0.0847	Negligible	Negligible	Negligible
SO_2 emissions (kg/MWh)[(c)]	0.3369	Negligible	0.3179	Negligible	Negligible	Negligible
SO_2 emissions (lb/MWh)[(c)]	0.7426	Negligible	0.7007	Negligible	Negligible	Negligible
NO_x emissions (lb/hr)	357	528	336	479	34	34
NO_x emissions (tons/yr) @ CF[(b)]	1,331	1,966	1,250	1,784	127	127
NO_x emissions (lb/MBtu)	0.070	0.070	0.070	0.070	0.009	0.009
NO_x emissions (kg/MWh)[(c)]	0.278	0.352	0.263	0.328	0.027	0.030
NO_x emissions (lb/MWh)[(c)]	0.613	0.777	0.579	0.722	0.060	0.066
PM emissions (lb/hr)	66	98	62	89	Negligible	Negligible
PM emissions (tons/yr) @ CF[(b)]	247	365	232	331	Negligible	Negligible
PM emissions (lb/MBtu)	0.0130	0.0130	0.0130	0.0130	Negligible	Negligible
PM emissions (kg/MWh)[(c)]	0.052	0.065	0.049	0.061	Negligible	Negligible
PM emissions (lb/MWh)[(c)]	0.114	0.144	0.107	0.134	Negligible	Negligible
Hg emissions (lb/hr)	0.0058	0.0086	0.0055	0.0078	Negligible	Negligible
Hg emissions (tons/yr) @ CF[(b)]	0.022	0.032	0.020	0.029	Negligible	Negligible
Hg emissions (lb/MBtu)	1.14	1.14	1.14	1.14	Negligible	Negligible
Hg emissions (kg/MWh)[(c)]	4.54×10^{-6}	5.75×10^{-6}	4.29×10^{-6}	5.35×10^{-6}	Negligible	Negligible
Hg emissions (lb/MWh)[(c)]	1.00×10^{-5}	1.27×10^{-5}	9.45×10^{-6}	1.18×10^{-5}	Negligible	Negligible

(a) NA = not applicable.
(b) Capacity factor (CF) is 80 percent for IGCC cases and 85 percent PC and NGCC cases.
(c) Value is based on gross output.
(d) Value is based on net output.
Source: NETL 2007

4.3.2.3 Renewable Alternatives

Construction—Air quality and noise impacts for the construction of land-based alternative energy technologies would be the same as described in Section 4.3.2. Air quality impacts associated with the construction of offshore power generating facilities and support structures include the emission of criteria pollutants from construction barges and equipment (e.g., cranes, compressors) and vehicles delivering materials and crews to embarkation locations on the shore, and dust from the construction of onshore facilities (e.g., cable landings, substations).

Construction-related noise impacts would be substantially different offshore than those associated with onshore construction since these activities would be distant from most human receptors and because noise propagates much greater distances in water. Marine animals that use noise for navigation (e.g., echolocation) would be affected by construction-related noise. Sources of noise would include crew vessels and construction and equipment barges; seismic technologies used to characterize the site; explosives or pile driving to construct foundations for offshore wind turbines or anchoring devices for wave, tidal, and current energy capturing equipment; and excavation of sea bottoms for installation of buried power and communication cables. Construction-related impacts on air quality and noise would generally be temporary.

Operations—The operational impacts of alternative energy technologies on air quality and noise are presented in the following subsections.

Hydroelectric Energy Sources

Air quality would be affected by minor emissions of criteria pollutants during plant operations, primarily from workforce vehicles and internal combustion engines on pumps, air compressors, emergency power generators, and other support equipment.

Geothermal

Air quality would be affected by the release of criteria pollutants from vehicles and equipment utilizing internal combustion engines. Air quality would be affected by the release of dissolved hydrogen sulfide from geothermal fluids during well operation; installation of hydrogen sulfide control/capture devices on wellheads would be required to regulate release to acceptable levels. Air quality would be affected by the release of greenhouse gases, estimated to be 1,570 lb/hr of greenhouse gases (carbon dioxide 92.3 percent, methane 0.1 percent) during operation. Greenhouse gas emission rate is approximately 26 times less than the rate of release from a fossil fuel-fired power plant. Air quality could also be affected by the release of small amounts of acid rain precursors (NO_x, SO_2).

During winter months, air quality and visibility would be affected by ground-level fogging/icing that could occur from cooling towers. Ambient noise levels would be affected by cooling towers, compressors, and internal combustion engines and manipulation of fluids under high pressure. Noise could be as much as 45 dB above background at offsite locations.

Wind

Wind farms would have no discernible impacts on air quality. Noise impacts would include aerodynamic noise from the turbine rotor and mechanical noise from turbine drivetrain components.

Noise from offshore wind farms consisting of aerodynamic and mechanical noise from the wind turbine transmitted underwater via the tower could affect marine species, especially those that use echolocation to navigate. Onshore components of offshore wind facilities would affect land animals when located at or near important habitats. Because of water density, noise travels proportionally greater distances under water; thus, the area over which noise impacts may occur would be much greater for offshore wind farms.

Biomass

Air impacts would result from feedstock handling activities (storage, crushing/grinding, loading conveyors, etc.) and combustion. Combustion of biomass generally results in smaller amounts of greenhouse gas (primarily CO_2) than combustion of fossil fuel. For some biomass sources such as energy crops, the amount of CO_2 released during their combustion is roughly equivalent to the amount absorbed by the plants during their growing cycle. Except for greenhouse gas emissions of vehicles and equipment used to plant, cultivate, and harvest, energy crops are considered to be greenhouse gas-neutral with respect to their application in electrical energy production. Conversion to energy of biomass that would otherwise be managed as a solid waste represents a net greenhouse gas “sink” since combustion for energy production avoids the greenhouse gas emissions (primarily methane) that would have resulted from the landfilling and decomposition of such materials. Example criteria pollutant impacts (in lb/MWh; NREL 2003) include:

SO_x	Wood waste burned in stoker boiler	0.08
	Fluidized bed combustion	0.08
	Energy crops combusted in IGCC system	0.05
NO_x	Wood waste burned in stoker boiler	2.1
	Fluidized bed combustion	0.9
	Energy crops combusted in IGCC system	2.2

CO	Wood waste burned in stoker boiler	12.2
	Fluidized bed combustion	0.17
	Energy crops combusted in IGCC system	0.23
PM_{10}	Wood waste burned in stoker boiler	0.50
	Fluidized bed combustion	0.3
	Energy crops combusted in IGCC system	0.01

A 200-MW co-firing wood biomass coal facility (where biomass is 15 percent of the total heat input) operating in 2030 with an 80 percent capacity factor providing 771 GWh/yr electricity would have the following air emissions (EERE 1997):

SO_2 40,544 T/yr (36,200 MT/yr)

CO_2 3,248,224 T/yr (2,900,200 MT/yr)

Noise impacts from biomass combustion facilities would be similar in nature and magnitude to coal-fired plants of equivalent size and capacity.

Municipal Solid Waste, Refuse-Derived Fuel, and Landfill Gas

Air impacts from combustion of refuse-derived fuel would depend on the quality of the fuel. Criteria and hazardous air pollutants could be released if not removed during refuse-derived fuel production. Air pollutants of concern include hydrochloric acid, nitric oxide (NO), sulfuric acid, arsenic, cadmium, chromium (VI), dioxins/furans, various polycyclic aromatic hydrocarbons (PAHs), chlorinated benzenes, dienes, phenols, and polychlorinated biphenyls (PCBs). Air quality could be affected by the release of dioxins and other PAHs from the incomplete combustion of fuel. Noise impacts from municipal solid waste, refuse-derived fuel, and landfill gas combustion facilities would be similar in nature and intensity to coal-fired and natural gas-fired power plants. Noise sources would include municipal solid waste feedstock preparation activities (cutting grinding, etc., to produce a feedstock of uniform size) and pump and compressor noise from the collection and transfer of landfill gas.

Solar Thermal

Dust could be released due to the removal of vegetation. Noise during operations would include mechanical noise from operation of powerblock components (steam cycle and cooling system pumps, turbines, and generators), and pump noise from circulation of heat transfer fluids, cooling tower noise (fans, cascading water).

Solar Photovoltaic

Dust could be released from the plant site due to the removal of vegetation. Individual photovoltaic cells could release toxic heavy metals to the atmosphere (primarily cadmium, selenium, and arsenic) in the event of fire. Virtually no discernible noise or air quality impacts would result from the routine operation of the facility.

Ocean Wave and Current

Air quality would be only minimally affected by facility operation; air quality would be affected by the release of criteria pollutants during periodic inspection, maintenance, and repair; vessels are expected to burn low-sulfur diesel fuel. Onshore air quality would be affected by the release of criteria pollutants from workforce vehicles and the possible release of fugitive dust from onshore support facilities. Mechanical noise from moving parts and hydrodynamic noise from the interaction of turbine blades with water would minimally affect the ambient above-water noise environment; underwater noise sources (primarily turbine blades, mechanical noise from other moving parts, and vessel propellers) could travel great distances and could affect marine organisms, especially those utilizing echolocation.

4.4 Geologic Environment

4.4.1 Environmental Consequences of the Proposed Action—Continued Operations and Refurbishment Activities

Geology and Soils

The impacts on geology and soils during the license renewal term were not considered in the 1996 GEIS. Geologic and soils conditions at all nuclear power plants and associated transmission lines have been well established during the current licensing term. These conditions are expected to remain unchanged during the 20-year license renewal term.

The impact of continued operations and refurbishment associated with license renewal on geologic and soil resources would consist of soil disturbance, including sediment and/or any associated bedrock, for projects, such as replacing or adding buildings, roads, parking lots, and belowground and aboveground utility structures. Implementing BMPs would reduce soil erosion and subsequent impacts on surface water quality. These practices include, but are not limited to, minimizing the amount of disturbed land, stockpiling topsoil before ground disturbance, mulching and seeding in disturbed areas, covering loose materials with geotextiles, using silt fences to reduce sediment loading to surface water, using check dams to minimize the erosive power of drainages, and installing proper culvert outlets to direct flows in streams or drainages.

Detailed geotechnical analyses would be required to address the stability of excavations, foundation footings, and slope cuts for building construction, road creation, or other refurbishment-related construction projects. Depending on the plant location and design, riverbank or coastline protection might need to be upgraded, especially at water intake or discharge structures, if natural flows, such as storm surges, cause an increase in erosion. In addition, the Farmland Protection Policy Act (7 USC 4201 et seq.) requires Federal agencies to take into account agency actions affecting the preservation of farmland including prime and other important farmland soils, as described in Section 3.4. While the Farmland Protection Policy Act could apply in some circumstances at nuclear power plant sites (e.g., development of renewable energy resources as an alternative to license renewal, other projects completed with Federal assistance including funding), it does not apply to Federal permitting or licensing actions for activities on private or non-Federal lands (7 CFR 658.2).

Plant-specific environmental reviews conducted by the NRC to date have not identified any significant impact issues related to geology and soils.

As discussed in Section 3.4, nuclear power plants were originally sited, designed, and licensed in consideration of the geologic and seismic criteria set forth in 10 CFR 100.10(c)(1) and 10 CFR Part 100, Appendix A, and constructed in accordance with 10 CFR Part 50, Appendix A. In its license renewal environmental reviews, the NRC considers the risk to reactors from seismicity in the evaluation of severe accident mitigation alternatives. Where appropriate, seismic issues are also assessed in the site-specific safety review that is performed for license renewals.

Further, the NRC requires all licensees to take seismic activity into account in order to maintain safe operating conditions at all nuclear power plants. When new seismic hazard information becomes available, the NRC evaluates the new information to determine if any changes are needed at existing plants. This reactor oversight process, which includes seismic safety, is separate and distinct from license renewal.

Consequently, the impact of continued operations during the license renewal term and refurbishment activities relative to the geologic environment would be SMALL for all nuclear plants and a Category 1 issue.

4.4.2 Environmental Consequences of Alternatives to the Proposed Action

Construction—For all alternatives (including fossil energy, new nuclear, and renewable alternatives) discussed in this section, the impacts of construction on geology and soils would be similar. Land would be cleared of vegetation during construction. Soils would be stored onsite for redistribution at the end of construction. Land clearing during construction and the installation of power plant structures and impervious pavements would alter surface drainage.

Natural drainage patterns at brownfield sites have been previously altered. Sources of aggregate such as crushed stone and sand and gravel would be required for construction of buildings, foundations, roads, and parking lots.

4.4.2.1 Fossil Energy Alternatives

Operations—Impacts on soil and geologic resources during power plant operations would be limited to the extraction of fossil fuel, typically at existing mining and drilling locations far from the power plant. Surface mining or underground mining for coal would result in various degrees of overburden clearing, soil stockpiling, waste rock disposal, re-routing of drainages, and management of any co-located geologic resources. Eventual mine closure would require proper restoration efforts to reduce the impact of erosion of replaced topsoil. Drilling for petroleum resources would involve clearing and grading for drill pads and construction of underground pipelines with associated soil disturbance. Proper design of surface water crossings would be needed to manage the potential for erosion at these locations.

4.4.2.2 New Nuclear Alternatives

Operations—Impacts on soil and geologic resources during operation would be limited to the extraction of ore material used to make nuclear fuel, typically at existing mining locations far from the power plant. The extraction could involve mining techniques similar to those used for fossil fuels, along with management of ore tailings. An alternative method is solution mining, which would involve the construction of drilling pads, similar to those used for the extraction of petroleum.

4.4.2.3 Renewable Alternatives

Operations—The operational impacts of alternative energy technologies on geology and soils are presented in the following subsections.

Hydroelectric Energy Sources

Geology and soils in the immediate area of a dam and reservoir would be affected by sedimentation in the reservoir basin and changes in upstream and downstream erosion patterns. Dams would induce downstream impacts such as low and high flow conditions, changes in sediment transport and deposition patterns, and channel erosion or scouring.

Geothermal

The injection of cooled geothermal fluids might induce microseismic activity. The removal of large quantities of groundwater could result in land subsidence. The alternative of engineered geothermal systems applied to hot, dry rock resources would avoid the possibility of subsidence.

Biomass

Soils would be affected by contaminants potentially present in runoff from unprotected piles of feedstock materials, fly ash and bottom ash, and scrubber sludge. Farming could result in soil erosion and the release of pesticides and fertilizers to nearby water bodies or to shallow groundwater aquifers.

Solar Thermal and Photovoltaic

This alternative requires a large amount of land. To avoid a fire hazard, solar collection devices would need to be kept free of vegetation. This practice could result in soil erosion in cleared areas by wind and precipitation runoff.

4.5 Water Resources

Hydrologic and water quality conditions at all nuclear power plants and associated transmission lines have been well established during the current licensing term. However, continued operations and refurbishment activities could have an impact on water resources during the license renewal term. This section describes the potential impact of these proposed activities and alternatives to these proposed activities on surface water and groundwater resources.

4.5.1 Environmental Consequences of the Proposed Action—Continued Operations and Refurbishment Activities

Continued operations and refurbishment activities during the license renewal term could affect surface water and groundwater resources in a manner similar to what has occurred during the current license term (see Sections 3.5.1 and 3.5.2, respectively).

4.5.1.1 Surface Water Resources

For the most part, no significant surface water impacts are anticipated during the license renewal term that would be different from those occurring during the current license term. Certain operational changes (such as a power uprate) affecting surface water would be evaluated by the NRC in a separate environmental assessment. For potential impacts to water resources, the use of surface water is of greatest concern because of the high volumetric flow rates required for condenser cooling at power plants. Withdrawals from surface water bodies are high for both once-through and closed-cycle cooling systems. Consumptive water use occurs through evaporation and drift, especially from cooling towers, and may affect water availability downstream from plants along rivers. Associated impacts on surface water quality may result from the discharge of thermal effluent containing chemical additives. Other potential impacts on surface water are the result of normal industrial plant activities during the license renewal term.

The following issues concern impacts on surface water that may occur during the license renewal term:

- Surface water use and quality (non-cooling system impacts) (consolidation and expansion of two issues evaluated in the 1996 GEIS: (1) impacts of refurbishment on surface water quality and (2) impacts of refurbishment on surface water use);
- Altered current patterns at intake and discharge structures (evaluated in the 1996 GEIS);
- Altered salinity gradients (evaluated in the 1996 GEIS);
- Altered thermal stratification of lakes (evaluated in the 1996 GEIS);
- Scouring caused by discharged cooling water (evaluated in the 1996 GEIS);
- Discharge of metals in cooling system effluent (evaluated in the 1996 GEIS);
- Discharge of biocides, sanitary wastes, and minor chemical spills (consolidation of two issues evaluated in the 1996 GEIS: (1) discharge of chlorine or other biocides and (2) discharge of sanitary wastes and minor chemical spills);
- Surface water use conflicts (plants with once-through cooling systems) (evaluated in the 1996 GEIS);
- Surface water use conflicts (plants with cooling ponds or cooling towers using makeup water from a river) (issue was modified from the 1996 GEIS to include all rivers);
- Effects of dredging on surface water quality (new issue not considered in the 1996 GEIS); and
- Temperature effects on sediment transport capacity (evaluated in the 1996 GEIS).

Surface Water Use and Quality (Non-Cooling System Impacts)

This issue is a consolidation and expansion of two 1996 GEIS issues (impacts of refurbishment on surface water quality and impacts of refurbishment on surface water use). Continued operations and refurbishment activities could result in the degradation of water quality within the receiving watershed. Power plant sites and land-disturbing activities can increase the variety and quantity of pollutants entering receiving water bodies such as streams, rivers, and lakes. Pollutants within stormwater runoff from plant sites can include suspended sediment; pesticides and nutrients from landscaped areas; oil, grease, and toxic chemicals from motor vehicles; spills of hydrocarbon fuels; paints; road salts; heavy metals from roof shingles and motor vehicles; and thermal pollution from impervious surfaces. These pollutants could potentially harm aquatic and terrestrial species, contaminate recreational areas, and degrade drinking water supplies.

In an effort to minimize or eliminate impacts to the water quality of receiving water bodies, BMPs are typically included as conditions within NPDES permits. BMPs are measures used to control the adverse stormwater-related effects of land disturbance and development. They include structural devices designed to remove pollutants, reduce runoff rates and volumes, and protect aquatic habitats. BMPs also include nonstructural or administrative approaches, such as training to educate staff on the proper handling and disposal of potential pollutants.

Permanent BMPs are designed to control pollutants to the maximum extent practicable during continued operations of the power plant. Extended detention and infiltration basins are examples of pollutant removal features designed to remove pollutants based on volume. Hydrodynamic separator systems (hydrodynamic devices, baffle boxes, swirl concentrators, or cyclone separators) and other devices are examples of pollutant removal devices that are typically designed based on flow rate.

Refurbishment activities involving construction-related land disturbance are expected to be managed by an approved Stormwater Pollution Prevention Plan (SWPPP). The SWPPP would indicate the structural and non-structural BMPs that must be implemented for the duration of the refurbishment activity. Examples of construction BMPs include use of sediment (silt) fences, check dams, staked hay bales, sediment ponds, and mulching and geotextile matting of disturbed areas.

BMPs and conformance to plant site NPDES permits, encompassing those covering stormwater discharges associated with construction and industrial activity, are expected to be followed during continued operations and refurbishment activities. Implementation of spill prevention and control plans would further reduce the likelihood of any liquid chemical spills.

Continued operations and refurbishment activities will require water for non-cooling-related purposes, including some consumptive use (i.e., water that is used but not returned to the source and effectively lost). The water source is dependent on the nuclear power plant site, water availability, and the nature of any refurbishment activities. Typical water sources at nuclear plants are surface water, groundwater, and public domestic (potable) water.

Water may be used during refurbishment activities for concrete production, dust control, washing stations, facility and equipment cleaning, and soil compaction and excavation backfilling. However, the impacts due to the volume of water consumed from a surface water source would be insignificant when compared with that used and consumed by a plant's cooling system.

The use of groundwater for non-cooling system uses would have a similar, minimal impact on the surface water source as a direct surface water withdrawal, assuming an interconnection between the groundwater source and surface water body. Groundwater withdrawal near a water body with a disconnected groundwater table would have no effect on the surface water resource.

The use of public domestic water would reduce the direct consumptive use impacts on surface water resources. Still, domestic water runoff and water main breaks have the potential to introduce an additional pollutant (residual chlorine), which could impact water quality. It is expected that such occurrences would be rare and would be identified and corrected as piped domestic water is metered at the point of interconnection with a plant's water distribution system. Any such occurrences are not expected to present a significant water quality concern over the license renewal term.

Surface water consumption for non-cooling water-related operational activities is anticipated to be negligible and limited to such uses as facility and equipment cleaning. As a result, no surface use conflicts would be expected.

The impacts of refurbishment on surface water use and quality during the license renewal term were considered to be SMALL for all plants and were designated as Category 1 issues in the 1996 GEIS, and non-cooling system operational impacts on water use and quality are expected to be SMALL, as described above. In addition, if refurbishment took place during a reactor shutdown, the overall water use by the facility would be greatly reduced. No new information in plant-specific SEISs or associated literature has been identified that would change this conclusion. On the basis of these considerations, the non-cooling system impacts of continued operations and refurbishment activities on surface water resources would be SMALL for all nuclear plants. This is a Category 1 issue.

Altered Current Patterns at Intake and Discharge Structures

The large flow rates associated with cooling system water use have the potential to alter current patterns. The degree of influence depends on the design and location of the intake and discharge structures and the characteristics of the surface water body. The effect on currents near the intake and discharge locations is expected to be localized, and any problems would have been mitigated during the early operational period of a plant (NRC 1996). Most nuclear power plants are sited on large bodies of water to make use of the water for cooling purposes. The size of large rivers, lakes, or reservoirs precludes significant current alterations except in the vicinity of the structures. For ocean shore or bay settings, the effect is further reduced when compared with the strong natural water movement patterns. For example, current patterns have been modified at the Oyster Creek plant, which is located inland from Barnegat Bay in New Jersey. The once-through cooling system for this plant was created by modifying two small rivers originally flowing parallel into the bay. On the north side of the plant, the South Branch of the Forked River was enlarged between the plant and the bay to serve as an intake canal. On the south side of the plant, Oyster Creek was enlarged between the plant and the bay for use as a discharge canal. Near the plant, the two waterways were joined. Bay water is pulled from the bay through the intake canal to the plant, against the original flow direction of the lowest reach of the South Branch of the Forked River. Flow at the mouth of this river is therefore both reversed and significantly increased, while flow at the mouth of the Oyster Creek discharge canal is significantly increased. While current patterns in Barnegat Bay in the immediate vicinity of the intake and discharge canals are affected by operations, the effect is minor on the overall Barnegat Bay system (NRC 1996, 2007b).

This issue has no relevance to plants relying on cooling ponds because they are man-made features without natural currents.

Impacts from altered current patterns at intake and discharge structures during the license renewal term were considered to be SMALL for all plants and were designated as a Category 1 issue in the 1996 GEIS. No new information has been identified in plant-specific SEISs or associated literature that would change this conclusion. On the basis of these considerations, the impact of altered current patterns at intake and discharge structures would be SMALL for all nuclear plants and remains a Category 1 issue.

Altered Salinity Gradients

This issue relates to plants located on estuaries and addresses changes in salinity caused by cooling system water withdrawals and discharges. Using the same example site as for the current patterns issue, the Oyster Creek plant's construction included modification of the lower reaches of two creeks. These portions of the creeks were originally brackish, with a mix of freshwater from their upper reaches and tidally influenced bay water. Because of the cooling system operations, the water quality of these lower reaches now essentially matches that of Barnegat Bay, with contributions of freshwater from their upper reaches being relatively minor. These lower reaches are also affected by occasional dredging activities, and the discharge canal receives water to which heat and chemicals have been added. The salinity changes do not affect the upper portions of these streams. In the 1996 GEIS, only minor effects had been noted in Barnegat Bay.

As documented in the 1996 GEIS and Calvert Cliffs SEIS (NRC 1999b), the NRC found that the Calvert Cliffs plant on the Chesapeake Bay has not had significant effects on bay salinity. Altered salinity gradients are expected to be noticeable only in the immediate vicinity of intake and discharge structures.

Impacts from altered salinity gradients at intake and discharge structures during the license renewal term were considered to be SMALL for all plants and were designated as Category 1 issues in the 1996 GEIS. No new information has been identified in plant-specific SEISs or associated literature that would alter this conclusion. On the basis of these considerations, the impact of altered salinity gradients would be SMALL for all nuclear plants and remains a Category 1 issue.

Altered Thermal Stratification of Lakes

Because cooling systems typically withdraw from the deeper, cooler portion of the water column of lakes or reservoirs and discharge to the surface, they have the ability to alter the thermal stratification of the surface water. This is not considered an issue for rivers or oceans because of mixing caused by natural turbulence.

A thermal plume of discharge water loses heat to the atmosphere and to the receiving surface water body. It also undergoes mixing with the surface water. In the 1996 GEIS, examples included the Oconee plant in South Carolina, where the withdrawal of cool, deep water for cooling purposes favors warmwater fish species at the expense of coolwater fish. Mitigation of this effect is possible by modifying the allowable discharge water temperature. In an example from the McGuire power plant in North Carolina, a modeling study indicated that increasing the permitted discharge temperature would reduce the withdrawal of cool, deep water and conserve coolwater species habitat.

Thermal plumes may be studied through field measurements and modeling studies. For plants on lakes or reservoirs, the thermal effect on stratification is examined periodically through the National Pollutant Discharge Elimination System (NPDES) permit renewal process. Problems with thermal stratification due to nuclear power plant operations have not been encountered.

Impacts from altered thermal stratification of lakes and reservoirs during the license renewal term were considered to be SMALL for all plants and were designated as Category 1 issues in the 1996 GEIS. No new information has been identified in plant-specific SEISs or associated literature that would alter this conclusion. On the basis of these considerations, the impact of altered thermal stratification of lakes would be SMALL for all nuclear plants and remains a Category 1 issue.

Scouring Caused by Discharged Cooling Water

The high flow rate of water from a cooling system discharge structure has the potential to scour sediments and redeposit them elsewhere. The scouring will remove fine-grained sediments, resulting in turbidity, and leave behind coarse-grained sediments.

The degree of scouring depends on the design of the discharge structure and the character of the sediments. Scouring is expected to occur only in the vicinity of the discharge structure where flow rates are high. While scouring is possible during reactor startup, operational periods would typically have negligible scouring. Natural sediment transport processes could bring fresh sediment into the discharge flow area. These processes include transport due to ocean currents, tides, river meandering, and storm events.

In the 1996 GEIS, scouring had not been noted as a problem at most plants and had been observed at only three nuclear power plants (Calvert Cliffs, Connecticut Yankee [no longer operating], and San Onofre). The effects at these plants were localized and minor.

Impacts from scouring caused by discharged cooling water during the license renewal term were considered to be SMALL for all plants and were designated as a Category 1 issue in the 1996 GEIS. No new information has been identified in plant-specific SEISs or associated literature that would alter this conclusion. On the basis of these considerations, the impact of scouring caused by discharged cooling water is SMALL for all nuclear plants and remains a Category 1 issue.

Discharge of Metals in Cooling System Effluent

Heavy metals such as copper, zinc, and chromium can be leached from condenser tubing and other components of the heat exchange system by circulating cooling water. These metals are normally addressed in NPDES permits because high concentrations of them can be toxic to aquatic organisms. During normal operations, concentrations are normally below laboratory detection levels. However, plants occasionally undergo planned outages for refueling, with stagnant water remaining in the heat exchange system. During an outage at the Diablo Canyon plant in California, the longer residence time of water in the cooling system resulted in elevated copper levels in the discharge when operations resumed; abalone (*Haliotis* spp.) deaths were attributed to the increased copper (NRC 1996). At the Robinson plant in South Carolina, the gradual accumulation of copper in its reservoir resulted in impacts on the bluegill (*Lepomis macrochirus*) population. In both cases, copper condenser tubes were replaced with titanium ones, and the problem was eliminated (NRC 1996). Impacts from the discharge of metals in cooling system effluent during the license renewal term were considered to be SMALL for all plants and were designated as a Category 1 issue in the 1996 GEIS. No new information has been identified in plant-specific SEISs or associated literature that would alter this conclusion. On the basis of these considerations, the impact of the discharge of metals in cooling system effluent would be SMALL for all nuclear plants and remains a Category 1 issue.

Discharge of Biocides, Sanitary Wastes, and Minor Chemical Spills

The use of biocides is common and is required to control biofouling and nuisance organisms in plant cooling systems. However, the types of chemicals, their amounts or concentrations, and the frequency of their use may vary. The use of biocides at nuclear power plants was discussed generally in Section 3.5.1. Ultimately, any biocides used in the cooling system are discharged to surface water bodies. The discharge of treated sanitary waste also occurs at plants. Discharge may occur via onsite wastewater treatment facilities, via an onsite septic field, or through a connection to a municipal sewage system. Minor chemical spills collected in floor drains are associated with industry in general and are a possibility at all plants. Each of these factors represents a potential impact on surface water quality. In the 1996 GEIS, the impacts of these releases were evaluated as two issues: (1) discharge of chlorine or other biocides and (2) discharge of sanitary wastes and minor chemical spills. Here they are treated as a single issue.

Discharges of cooling water and other plant wastewaters are monitored through the NPDES program administered by the EPA, or, where delegated, individual States. The NPDES permit contains requirements that limit the flow rates and pollutant concentrations that may be discharged at permitted outfalls. The permit may also include biological monitoring parameters that are primarily associated with the discharge of cooling water. Wastewater discharge is also covered through NPDES permitting, and it includes biochemical monitoring parameters. Discharge from building drains is also addressed in the NPDES permit. Because of Federal or State regulatory involvement, and because regulatory and resource agencies have not found significant problems with outfall monitoring, the impacts from the discharge of chlorine and other biocides and minor spills of sanitary wastes and chemicals during license renewal and refurbishment were considered to be SMALL for all plants and designated as Category 1 issues in the 1996 GEIS. No new information has been identified in plant-specific SEISs or associated literature that would alter this conclusion. On the basis of these considerations, the discharge of biocides, sanitary wastes, and minor chemical spills would be SMALL for all nuclear plants and remains a Category 1 issue.

Surface Water Use Conflicts (Plants with Once-Through Cooling Systems)

Nuclear power plant cooling systems may compete with other users relying on surface water resources, including downstream municipal, agricultural, or industrial users. Once-through and closed-cycle cooling systems have different water consumption rates. Once-through cooling systems return most of their withdrawn water to the same surface water body, with evaporative losses of less than 3 percent (Solley et al. 1998). Consumptive use by plants with once-through cooling systems during the license renewal term is not expected to change unless power uprates, with associated increases in water use, are proposed. Such uprates would require an environmental assessment by the NRC.

Future scenarios for water availability focus on climate change and associated changes in precipitation and temperature patterns. Increased temperatures and/or decreased rainfall would result in lower river flows, increased cooling pond evaporation, and lowered water levels in the Great Lakes or reservoirs. While weather will vary from year to year, the results of climate change models and the projected changes to surface water runoff in the 21st century (NETL 2006) predicted increases in runoff in the eastern United States and decreases in runoff in the western United States, where water is currently less available. Regardless of overall climate change, droughts could result in problems with water supplies and allocations. Because future agricultural, municipal, and industrial users would continue to share their demands for surface water with power plants, conflicts might arise if the availability of this resource decreased. This situation would then necessitate decisions by local, State, and regional water planning officials.

Population growth around nuclear power plants has caused increased demand on municipal water systems, including systems that rely on surface water. Municipal intakes located downstream of a nuclear power plant could experience water shortages, especially in times of drought. Water demands upstream of a plant could impact the water availability at the plant's intake.

In the 1996 GEIS, impacts of continued operations and refurbishment on water use conflicts associated with once-through cooling systems were considered to be SMALL and were designated as a Category 1 issue. No new information has been identified in plant-specific SEISs or associated literature that would alter this conclusion. On the basis of these considerations, the NRC concludes that the impact on water use conflicts from the continued operation and refurbishment activities would be SMALL for plants that utilize once-through cooling and remains a Category 1 issue.

Surface Water Use Conflicts (Plants with Cooling Ponds or Cooling Towers Using Makeup Water from a River)

Nuclear power plant cooling systems may compete with other users relying on surface water resources, including downstream municipal, agricultural, or industrial users. Closed-cycle cooling is not completely closed, because the system discharges blowdown water to a surface water body and withdraws water for makeup of both the consumptive water loss due to evaporation and drift (for cooling towers) and blowdown discharge. For plants using cooling towers, the makeup water needed to replenish the consumptive loss of water to evaporation can be significant and is reported at 60 percent or more of the condenser flow rate by Solley et al. (1998). Cooling ponds will also require makeup water as a result of naturally occurring evaporation, evaporation of the warm effluent, and possible seepage to groundwater.

Consumptive use by plants with cooling ponds or cooling towers using makeup water from a river during the license renewal term is not expected to change unless power uprates, with associated increases in water use, are proposed. Such uprates would require an environmental assessment by the NRC. In the 1996 GEIS, application of this issue applied only to rivers with low flow[(a)] so as to define the difference between plants located on “small” versus “large” rivers. However, any river, regardless of size, can experience low flow conditions of varying severity during periods of drought and changing conditions in the affected watershed such as upstream diversions and use of river water. NRC has subsequently determined that use of the term “low flow” in categorizing river flow is of little value considering that all rivers can experience low flow conditions.

Further and as stated earlier, increased temperatures and/or decreased rainfall would result in lower river flows, increased cooling pond evaporation, and lowered water levels in the Great Lakes or reservoirs. Regardless of overall climate change, droughts could result in problems with water supplies and allocations. Conflicts might arise due to competing agricultural, municipal, and industrial user demands for surface water with power plants. Closed cooling systems are more susceptible to these issues than once-through cooling systems because they consume more water. For this reason, climate change is more of a potential concern for water use conflicts among closed systems.

Population growth around nuclear power plants has caused increased demand on municipal water systems, including systems that rely on surface water. Municipal intakes located downstream from a nuclear power plant could experience water shortages, especially in times of drought. Similarly, water demands upstream from a plant could impact the water availability at the plant’s intake.

(a) A river with low flow was previously defined in 10 CFR 51.53(c)(3)(ii)(A) and in the 1996 GEIS as one with an annual flow rate that is less than 3.15×10^{12} ft^3/yr (9×10^{10} m^3/yr).

As discussed in the 1996 GEIS, water use conflicts have also been observed for plants with closed-cycle cooling systems. The Limerick plant on the Schuylkill River in Pennsylvania is cited as an example of a plant on which limits were imposed on the rate of withdrawal from a river for the purpose of avoiding water use conflicts, including downstream water availability and water quality. Availability problems for downstream habitat and users may be anticipated at other plants.

Water use conflicts associated with plants with cooling ponds or cooling towers using makeup water from a river with low flow were considered to vary among sites because of differing site-specific factors, such as makeup water requirements, water availability (especially in terms of varying river flow rates), changing or anticipated changes in population distributions, or changes in agricultural or industrial demands. No new information has been identified in plant-specific SEISs or associated literature has been identified that would alter this conclusion.

On the basis of these considerations, the impact of water use conflicts from the continued operation of nuclear power plants with cooling ponds or cooling towers using makeup water from a river could be SMALL or MODERATE, depending on factors such as plant-specific design characteristics affecting consumptive water use, the characteristics of the water body serving as the source for makeup water, and the amount of competing use for that water. Because the impact could vary among nuclear plants, the issue continues to be Category 2.

Effects of Dredging on Surface Water Quality

Dredging in the vicinity of surface water intakes, canals, and discharge structures takes place in order to remove deposited sediment and maintain the function of plant cooling systems. Dredging may also be needed to maintain barge shipping lanes. Whether accomplished by mechanical, suction, or other methods, dredging disturbs sediments in the surface water body and affects surface water quality by temporarily increasing the turbidity of the water column. In areas affected by industries, dredging can also mobilize heavy metals, PCBs, or other contaminants in the sediments.

The frequency of dredging depends on the rate of sedimentation. At the Oyster Creek plant in New Jersey, dredging took place during site construction to create canals for the once-through cooling system (NRC 2007b). Depth measurements are performed there every two years, and dredging has taken place on portions of the canal system since construction. At the Susquehanna plant in Pennsylvania, the plant's river intake and diffuser pipe are dredged annually (NRC 2008b).

In general, maintenance dredging affects localized areas for a brief period of time. Dredging operations are performed under permits issued by the U.S. Army Corps of Engineers (USACE), and possibly from State or local agencies. The physical alteration of water bodies is regulated by Federal and State statutes under Section 401 (Certification) and Section 404 (Permits) of the Clean Water Act. The USACE regulates the discharge of dredged and/or fill material under Section 404, while Section 401 requires the applicant for a Section 404 permit to also obtain a Water Quality Certification from the State in order to confirm that the discharge of fill materials will be in compliance with applicable State water quality standards. If dredging could affect threatened or endangered species or critical habitat, as established under the Endangered Species Act, the USACE must consult with the U.S. Fish and Wildlife Service or the National Marine Fisheries Service (NMFS) before it makes a permit decision. In issuing a Section 404 permit, the USACE also considers other potential impacts on aquatic resources, archaeological resources, Tribal concerns, and the permitting requirements of State and local agencies. The permitting process may include planning for the sampling and disposal of the dredged sediments.

The impact of dredging has not been found to be a problem at operating nuclear power plants. Dredging has localized effects on water quality that tend to be short-lived. The impact of dredging on water quality would be SMALL for all nuclear plants and is considered a Category 1 issue.

Temperature Effects on Sediment Transport Capacity

Increased temperature and the resulting decreased viscosity have been hypothesized to change the sediment transport capacity of water, leading to potential sedimentation problems, altered turbidity of rivers, and changes in riverbed configuration. Coutant (1981) discussed the theoretical basis for such possible changes, as well as relevant field investigations, and concluded that there is no indication that this is a significant problem at operating power stations. Examples of altered sediment characteristics are more likely the result of power plant structures (e.g., jetties or canals) or current patterns near intakes and discharges; such alterations are readily mitigated.

Based on review of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and public comments on previous license renewal reviews, there is no evidence that temperature effects on sediment transport capacity have caused adverse environmental effects at any existing nuclear power plant. Regulatory agencies have expressed no concerns regarding the impacts of temperature on sediment transport capacity. Furthermore, because of the small area near a nuclear power plant affected by increased water temperature, it is not expected that plant operations would have a significant impact. Effects are considered to be of SMALL significance for all plants. No change in the operation of the cooling system is expected during the license renewal term so no change in effects on sediment transport capacity is anticipated. This issue remains Category 1.

4.5.1.2 Groundwater Resources

Operational activities during the license renewal term would be similar to those occurring during the current license term. The impact issues of concern are availability of groundwater and the effect of nuclear plant operations on groundwater quality.

The following eight issues concern impacts on groundwater that may occur during the license renewal term:

- Groundwater contamination and use (non-cooling system impacts) (issue was modified and expanded from the 1996 GEIS issue, "Impacts of refurbishment on groundwater use and quality," to include the impacts of continued operations including potential groundwater contamination);

- Groundwater use conflicts (plants that withdraw less than 100 gallons per minute [gpm]) (evaluated in the 1996 GEIS);

- Groundwater use conflicts (plants that withdraw more than 100 gallons per minute [gpm]) (consolidation of two issues from the 1996 GEIS: (1) groundwater use conflicts (potable and service water and dewatering; plants that use >100 gpm) and (2) groundwater use conflicts (Ranney wells));

- Groundwater use conflicts (plants with closed-cycle cooling systems that withdraw makeup water from a river) (issue was modified from the 1996 GEIS to include all rivers);

- Groundwater quality degradation resulting from water withdrawals (consolidation of two issues from the 1996 GEIS: (1) groundwater quality degradation (Ranney wells) and (2) groundwater quality degradation (saltwater intrusion));

- Groundwater quality degradation (plants with cooling ponds in salt marshes) (evaluated in the 1996 GEIS);

- Groundwater quality degradation (plants with cooling ponds at inland sites) (evaluated in the 1996 GEIS); and

- Radionuclides released to groundwater (new issue not considered in the 1996 GEIS).

Groundwater Contamination and Use (Non-Cooling System Impacts)

This renamed issue is an expansion of the issue “Impacts of refurbishment on groundwater use and quality” from the 1996 GEIS with the addition of the impacts of industrial activities associated with continued operations on groundwater use and quality.

As mentioned in Section 3.5.2, the original construction of some plants required dewatering of a shallow aquifer, and operational dewatering takes place at some plants including for groundwater contaminant plume control. This is accomplished by systems of pumping wells or drain tiles. Continued operations and refurbishment activities during the license renewal term are not expected to require any significant dewatering that would have an incremental effect on groundwater availability over that which has already taken place. Such dewatering impacts are expected to remain SMALL and confined to the boundaries of operating plants.

In the 1996 GEIS, the groundwater impacts associated with refurbishment activities were considered to be SMALL for all nuclear plants. No new information has been identified in plant-specific SEISs or associated literature that would alter this conclusion.

The contamination of groundwater and soil can result from general industrial practices at any site and is not limited to those occurring at nuclear power plants. Such industrial practices can be evaluated generically, as they are common to industrial facilities and nuclear power plants. Activities that result in contamination may include the use of solvents, hydrocarbon fuels (diesel and gasoline), heavy metals, or other chemicals. These materials all have the potential to affect groundwater and soil if released. Furthermore, contaminants present in the soil can act as long-term sources of contamination to underlying groundwater depending on the severity of the spill.

Based on previous plant-specific reviews, these types of groundwater and soil contamination problems have occurred at some operating plants. Release of contaminants into groundwater and soil degrades the quality of these resources, even if applicable groundwater quality standards are not exceeded. This includes *de minimis* quantities of contaminants that do not typically require reporting to regulatory agencies because they are below applicable threshold quantities and/or have been promptly remediated and would not otherwise pose a long-term threat to human health and the environment.

Examples of the types of contamination that may be present at a plant include hydrocarbon leaks or spills at a storage tank, leaked or spilled solvents from barrels, and a hydraulic oil line break (NRC 2006d), thallium in soil at a seepage pit, heavy metals in soil at a sand blasting site, a diesel fuel line leak, methyl tertiary butyl ether (MTBE) from spills of a gasoline storage tank, PCBs in soil as a result of former dielectric fluid use (NRC 2007b), and hydrocarbon spills and sulphuric acid leaks (NRC 2008b). These situations have required regulatory involvement by State agencies during both monitoring and remediation phases. Remediation has taken place in the form of excavation and recovery wells. In these instances, all contamination was either remediated with no further action required by regulatory agencies or has been confined to the plant site with remediation continuing, as with the ongoing recovery of diesel fuel at the Oyster Creek plant. Nevertheless, the number of occurrences of such problems can be minimized by means of proper chemical storage, secondary containment, and leak detection equipment. In addition, nuclear plants have their own programs for handling chemicals, waste, and other hazardous and toxic materials in accordance with Federal and State regulations and permits generally require the use of BMPs to prevent releases to the environment. Continued implementation of such programs and procedures such as pollution and spill prevention and control plans including BMPs (e.g., good housekeeping of the plant site, preventive maintenance, routine inspections, etc.) would reduce the likelihood of any inadvertent releases to soils and/or groundwater.

An additional source of groundwater contamination can be the use of wastewater ponds or lagoons. At the Cook plant in Michigan, permitted wastewater ponds are used for receiving treated sanitary wastewater and for process wastes from the turbine room sump. Groundwater monitoring has shown that concentrations of water quality parameters have increased to levels above background but below drinking water standards (NRC 2005a). As a result, in an arrangement with the county, the use of groundwater by other users in a designated area has been restricted with the affected groundwater limited to the southwestern portion of the plant property.

Contaminants in wastewater disposal ponds and lagoons, whether lined or unlined, at a plant have the potential to enter groundwater and soils. However, the use of wastewater disposal ponds and lagoons is subject to discharge authorizations under National Pollutant Discharge Elimination System (NPDES) and State wastewater discharge permit programs and monitoring.

Remediation of groundwater contamination can involve long-duration cleanup processes that depend on the types, properties, and concentrations of the contaminants; aquifer properties; groundwater flow field characteristics; and remedial objectives. Contaminants may be able to migrate to onsite potable wells or to the wells of offsite groundwater users. Groundwater monitoring programs, including monitoring of onsite drinking water quality in accordance with safe drinking water regulations, would be expected to identify problems before contaminated groundwater reached receptors; however, monitoring wells need to be present and in proper locations in order to detect contaminants.

On the basis of these considerations, the impact of continued operations during the renewal period and refurbishment activities on groundwater use would be SMALL for all nuclear plants. Further, the impact of plant industrial practices and their impact on groundwater quality associated with continued operations and refurbishment activities would continue to be SMALL. This issue is considered Category 1.

Groundwater Use Conflicts (Plants That Withdraw Less Than 100 Gallons per Minute [gpm])

Water wells are commonly used at sites to provide water for the potable water system, although municipal water is available at some nuclear plants. Groundwater may also be used for landscaping (see Section 3.5.2). At some sites, groundwater is the source for the makeup and service water systems. In this case, the water undergoes treatment to prepare it for the intended use.

The pumping of groundwater creates a cone of depression in the potentiometric surface around the pumping well. The amount the water table or potentiometric surface declines and the overall extent of the cone depend on the pumping rate, characteristics of the aquifer (e.g., its permeability), whether the aquifer is confined or unconfined, and certain boundary conditions (including the nearby presence of a hydrologically connected surface water body). Generally, plants with a peak withdrawal rate of less than 100 gpm (378 L/min) do not have a significant cone of depression. Their potential for causing conflict with other groundwater users would depend largely on the proximity of the other wells. As stated in the 1996 GEIS, cones of depression usually do not extend past the property boundary, reducing the possibility of a groundwater use conflict.

In the 1996 GEIS, the groundwater impacts associated with continued operations during the license renewal term were considered to be SMALL for all nuclear plants and designated as Category 1. No new information has been identified in plant-specific SEISs or associated literature that would alter this conclusion. On the basis of these considerations, the impact on groundwater use conflicts from continued operations during the license renewal term for all nuclear plants that withdraw less than 100 gpm (378 L/min) would be SMALL and remains a Category 1 issue.

Groundwater Use Conflicts (Plants That Withdraw More Than 100 Gallons per Minute [gpm])

This issue is a consolidation of two issues in the 1996 GEIS: (1) groundwater use conflicts (potable and service water and dewatering; plants that use >100 gpm) and (2) groundwater use conflicts (Ranney wells).

Nuclear power plants withdraw groundwater for various purposes. Most plants use groundwater to supply their potable water and service water needs. In some cases, groundwater is pumped to intentionally lower high water tables. At the Grand Gulf plant in Mississippi, Ranney wells in the Mississippi River alluvium are used to provide cooling system makeup water (see Section 3.5.2).

As described in the section above, the pumping of groundwater is expected to create a cone of depression around the well, with the degree of aquifer dewatering dependent on various factors. A nuclear plant may have several wells, with combined pumping in excess of 100 gpm (378 L/min). Overall site pumping rates of this magnitude have the potential to create conflicts with other local groundwater users if the cone of depression extends to the offsite well(s). Large offsite pumping rates for municipal, industrial, or agricultural purposes may, in turn, lower the water level at power plant wells. For any user, allocation is normally determined though a State-issued permit.

Groundwater use conflicts have not been observed at any nuclear power plants, and no significant change in water well systems is expected over the license renewal term. If a conflict did occur, it might be possible to resolve it if the power plant relocated its well or wellfield to a different part of the property. The siting of new wells would be determined through a hydrogeologic assessment.

In the 1996 GEIS, groundwater use conflicts were considered for plants that withdraw more than 100 gpm (378 L/min) or plants that use Ranney wells. The NRC concluded that the impacts of continued operations and refurbishment would not necessarily be the same at all nuclear plant sites (i.e., a Category 2 issue) because of site-specific factors (e.g., well pump rates, well locations, and hydrogeologic factors) and that the impacts could be SMALL, MODERATE, or LARGE. No new information has been identified in plant-specific SEISs or associated literature that would alter this conclusion. On the basis of these considerations, groundwater use conflicts for plants that withdraw more than 100 gpm (378 L/min) could be SMALL, MODERATE, or LARGE, depending on the plant-specific characteristics described above and remains a Category 2 issue.

Groundwater Use Conflicts (Plants with Closed-Cycle Cooling Systems That Withdraw Makeup Water from a River)

In the case of plants with cooling towers or cooling ponds that rely on a river for makeup of consumed (evaporated) cooling water, it is possible water withdrawals from the river could lead to groundwater use conflicts with other users. This situation could occur because of the interaction between groundwater and surface water, especially in the setting of an alluvial aquifer in a river valley. Consumptive use of the river water, if significant enough to lower the river's water level, would also influence water levels in the alluvial aquifer. Shallow wells of nearby groundwater users could therefore have reduced water availability or go dry. During times of drought, the effect would be occurring naturally, although withdrawals for makeup water would increase the effect. In the 1996 GEIS, a situation at the Duane Arnold plant in Iowa was described in which a reservoir on a small tributary is used as a secondary supply of makeup water for the plant's cooling towers. During low-flow conditions in the plant's usual source of water, the Cedar River, the plant is not allowed to withdraw river water. Instead, it uses the reservoir temporarily. Because the high rate of water usage can lower the water level in the reservoir significantly, local users of shallow groundwater may be affected. As described for other issues above, this situation is highly dependent on the area's hydrogeologic framework and the locations, depths, and pump rates of wells, in addition to the amount that the surface water level declines.

In the 1996 GEIS, groundwater use conflicts were evaluated for plants that use cooling towers withdrawing makeup water from a river during continued operations and refurbishment. NRC found that conflicts would not necessarily be the same at all nuclear plant sites because of site-specific factors (e.g., the amount of surface water decline, well pump rates, well locations, and hydrogeologic factors). The resulting impact could be SMALL, MODERATE, or LARGE. Therefore, this issue was considered Category 2. No new information has been identified in plant-specific SEISs or associated literature that would alter this conclusion. On the basis of these considerations, groundwater use conflicts for nuclear plants that use closed-cycle cooling systems that withdraw makeup water from a river could have SMALL, MODERATE, or LARGE impacts depending on the plant-specific characteristics of surrounding areas described above and remains a Category 2 issue.

Groundwater Quality Degradation Resulting from Water Withdrawals

This issue is a consolidation of two related issues in the 1996 GEIS: (1) groundwater quality degradation (Ranney wells) and (2) groundwater quality degradation (saltwater intrusion). These two issues both consider the possibility of groundwater quality becoming degraded as a result of drawing water of potentially lower quality into an aquifer. For this reason, they are discussed here as a single issue.

A well near a river may draw lower-quality river water into the aquifer as a function of the interaction between groundwater and surface water. An example of Ranney wells (see Section 3.5.2) at the Grand Gulf plant in Mississippi causing induced infiltration of Mississippi River water into the alluvial aquifer was discussed in the 1996 GEIS. While site-specific hydrogeologic factors and well design may provide some control on the flow of surface water to the well, the bulk of the groundwater pumped by a well in an alluvial aquifer near a river is expected to be induced surface water, with a smaller component of groundwater from the direction opposite the river. If well pumping is continuous, the only portion of the shallow aquifer significantly affected by induced infiltration remains in the capture zone of the well(s). Therefore, the portion of the aquifer with water quality parameters approaching those of the river water would usually be located on the power plant's property.

Wells in a coastal setting (e.g., ocean shore or estuary) have the potential to cause saltwater intrusion into the aquifer. This water quality problem is a common concern for large pumping centers associated with municipal or industrial users. The degree of saltwater intrusion depends on the cumulative pumping rates of wells, their screen depths, and hydrogeologic conditions. Deep, confined aquifers, for example, may be separated from saline aquifers closer to the surface. However, as evaluated in the 1996 GEIS, the potential for inducing saltwater intrusion was considered to be of SMALL significance at all sites because groundwater consumption from confined aquifers for potable and service water uses by nuclear power plants is a small fraction of groundwater use in all cases. Where saltwater intrusion has been a problem, the large users have been for agricultural (irrigation) and municipal water supply uses.

Impacts related to groundwater quality degradation for nuclear plants that use Ranney wells and groundwater quality degradation (saltwater intrusion) were designated as Category 1 issues in the 1996 GEIS. No new information has been identified in plant-specific SEISs or associated literature that would alter this conclusion. On the basis of these considerations, groundwater quality degradation resulting from water withdrawals would be SMALL for all nuclear plants and remains a Category 1 issue.

Groundwater Quality Degradation (Plants with Cooling Ponds in Salt Marshes)

Nuclear plants that use cooling ponds as part of their cooling water system discharge effluent to the pond. The effluent's concentration of contaminants and other solids increases relative to that of the makeup water as it passes through the cooling system. These changes include increased total dissolved solids (or TDS), since they concentrate as a result of evaporation, increased heavy metals (because cooling water contacts the cooling system components), and increased chemical additives to prevent biofouling. Because all the ponds are unlined (NRC 1996), the water discharged to them can interact with the shallow groundwater system and may create a groundwater mound. In this case, groundwater below the pond can flow radially outward, and this groundwater would have some of the characteristics of the cooling system effluent.

In salt marsh locations, the groundwater is naturally brackish (i.e., with a TDS concentration of about 1,000 to more than 10,000 milligrams per liter [mg/L]) and, thus, is already limited in its uses. As such, this issue concerns only the potential for changing the groundwater use category of the underlying shallow and brackish groundwater due to the introduction of cooling water contaminants. Two nuclear plants, South Texas in Texas and Turkey Point in Florida, have cooling systems (man-made cooling pond and cooling canal system, respectively) located relatively near or constructed in salt marshes. Plants relying on brackish water cooling systems would not further degrade the quality of the shallow aquifer relative to its use classification. This is because groundwater quality beneath salt marshes is already too poor for human use (i.e., it is non-potable water) and is only suitable for industrial use. Plants relying on cooling ponds in salt marsh settings are expected to have a SMALL impact on groundwater quality. This is the same conclusion reached in the 1996 GEIS. No new information has been identified in plant-specific SEISs or associated literature that would alter this conclusion. On the basis of these considerations, the impact of groundwater quality degradation for nuclear plants using cooling ponds in salt marshes would be SMALL and it remains a Category 1 issue.

Groundwater Quality Degradation (Plants with Cooling Ponds at Inland Sites)

The above discussion on cooling ponds relates to this issue. Some nuclear power plants that rely on unlined cooling ponds are located at inland sites surrounded by farmland or forest or undeveloped open land. Degraded groundwater has the potential to flow radially from the ponds and reach offsite groundwater wells. The degree to which this occurs depends on the water quality of the cooling pond; site hydrogeologic conditions (including the interaction of surface water and groundwater); and the location, depth, and pump rate of water wells. Mitigation of significant problems stemming from this issue could include lining existing ponds, constructing new lined ponds, or installing subsurface flow barrier walls. Groundwater monitoring networks would be necessary to detect and evaluate groundwater quality degradation. The degradation of groundwater quality associated with cooling ponds has not been reported for any inland nuclear plant sites.

The 1996 GEIS considered the impacts of this issue during continued operations and concluded that the impact would not necessarily be the same at all sites (i.e., a Category 2 issue) and could be SMALL, MODERATE, or LARGE. No new information has been identified in plant-specific SEISs or associated literature that would alter this conclusion.

On the basis of these considerations, the impacts of groundwater quality degradation for plants using cooling ponds at inland sites could be SMALL, MODERATE, or LARGE, depending on site-specific differences in the cooling pond's water quality; site hydrogeologic conditions (including the interaction of surface water and groundwater); and the location, depth, and pump rate of water wells. This issue remains Category 2.

Radionuclides Released to Groundwater

This is a new Category 2 issue. It has been added to the GEIS in order to evaluate the potential contamination of groundwater from the release of radioactive liquids from plant systems into the environment.

This issue was added because there were numerous instances of inadvertent releases of liquids containing radioactive material into the groundwater at nuclear power plants. The issue is relevant to license renewal because all commercial nuclear power plants routinely release radioactive gaseous and liquid materials into the environment. These radioactive releases are designed to be planned, monitored, documented, and released into the environment at designated discharge points. However, within the past several years, there have been numerous events at power reactor sites which involved unknown, uncontrolled, and unmonitored release of liquids containing radioactive material into the groundwater. NRC regulations in 10 CFR Part 20 and in 10 CFR Part 50 limit the amount of radioactive material, from all sources at a nuclear power plant, released into the environment to levels that are as low as is reasonably achievable (ALARA). The regulations are designed to protect the public and the environment.

The majority of the inadvertent liquid release events involved tritium, which is a radioactive isotope of hydrogen. However, other radioactive isotopes, such as cesium and strontium, have also been inadvertently released into the groundwater. The types of events include leakage from spent fuel pools, buried piping, and failed pressure relief valves on an effluent discharge line.

In 2006, the NRC's Executive Director for Operations chartered a task force to conduct a lessons-learned review of these incidents. On September 1, 2006, the task force issued its report: *Liquid Radioactive Release Lessons Learned Task Force Report* (NRC 2006a).

The most significant conclusion dealt with the potential health impacts on the public from the inadvertent releases. Although there were numerous events where radioactive liquid was released to the groundwater in an unplanned, uncontrolled, and unmonitored fashion, based on the data available, the task force did not identify any instances where public health and safety was adversely impacted.

Specific examples from NRC (2006a) focus on tritium releases at 15 plants. Concentrations of tritium in sampled onsite groundwater at many of these plants ranged well above the EPA drinking water standard of 20,000 pCi/L. Examples include onsite monitoring well samples of up to 250,000 pCi/L at the Braidwood plant in Illinois, up to 211,000 pCi/L at the Indian Point plant in New York (NRC 2008c), up to 486,000 pCi/L at the Dresden plant in Illinois, more than 30,000 pCi/L at the Watts Bar plant in Tennessee, and 71,400 pCi/L at the Palo Verde plant in Arizona. Examples of samples taken either directly from the source of the leak or from nearby onsite monitoring wells include samples with up to 200,000 pCi/L of tritium at the Callaway plant in Missouri, up to 15,000,000 pCi/L at the Salem plant in New Jersey, and up to 750,000 pCi/L at the Seabrook plant in New Hampshire. At the Byron plant in Illinois, tritium in monitoring wells was above the background level but below drinking water standards (up to 3,800 pCi/L). The location and construction of the monitoring wells relative to potential leak locations have not been evaluated. For each example, it is possible that a different well placement could detect higher or lower activity concentrations.

Other reported instances (NRC 2006a) of tritium above background levels have been a result of operator error, licensed discharge, or leaks or discharges to drain systems. At the Oyster Creek plant in New Jersey, a mistake involving a valve allowed tritium-contaminated water to flow to the discharge canal. Sampling of this water showed levels of 16,000 pCi/L. At the Wolf Creek plant in Kansas, an onsite lake receiving liquid effluent was found to have a tritium activity concentration of 13,000 pCi/L (NRC 2008a). The Perry plant in Ohio had water samples in its drainage system with an activity concentration of 60,000 pCi/L. In each of these cases, the tritium present at the surface could infiltrate or seep into the groundwater system.

The NRC does not consider the referenced tritium releases to be a health risk to the public or onsite workers (NRC 2006a) because the tritiated groundwater is expected to remain onsite. However, an exception is the event at Braidwood, which resulted in detectable concentrations of tritium at an offsite location. Sampling of an offsite residential well at Braidwood showed 1,600 pCi/L of tritium which is above the background level but well below EPA's drinking water standard. There would be no potential for risk to workers unless onsite wells were used for the potable water system and if the leak was in the capture zone of the well. However, the NRC requires that the onsite potable well water be monitored for radioactivity to protect plant workers.

The task force identified that under current NRC regulations the potential exists for unplanned, uncontrolled, and unmonitored releases of radioactive liquids to migrate offsite into the public domain. The following elements collectively contribute to this conclusion:

- Some of the power plant components that contain radioactive fluids that have leaked were constructed to commercial standards, in contrast to plant safety systems that are typically fabricated to more stringent requirements. The result is a lower level of assurance that these types of components will be leak proof over the life of the plant.

- Some of the components that have leaked were not required by NRC requirements to be subject to surveillance, maintenance, or inspection activities by the licensee. This increases the likelihood that leakage in such components can go undetected. Additionally, relatively low leakage rates may not be detected by plant operators, even over an extended period of time.

- Portions of some components or structures are physically not visible to operators, thereby reducing the likelihood that leakage will be identified. Examples of such components include buried pipes and spent fuel pools.

- Leakage that enters the ground below the plant may be undetected because there are generally no NRC requirements to monitor the groundwater onsite for radioactive contamination unless an onsite well is used for drinking water or irrigation.

- Contamination in groundwater onsite may migrate offsite undetected. Although the power plant operator is required by NRC regulations to perform offsite environmental monitoring, the sampling locations are typically in the vicinity of the routine effluent discharge point into the environment, not around plant systems, piping, and tanks containing radioactive liquids.

Another aspect encountered by the NRC due to the inadvertent releases was the high level of concern from the public, even at the very low radiation levels caused by the events. There has also been significant media coverage and demands by State and local government officials and members of Congress for the NRC to take action to stop these events.

On the basis of the information and experience with these leaks, the NRC concludes that the impact to groundwater quality from the release of radionuclides could be SMALL or MODERATE, depending on the magnitude of the leak, radionuclides involved, hydrogeologic factors, the distance to receptors, and the response time of plant personnel to identify and stop the leak in a timely fashion. Since the leaks are not planned and there are currently no NRC regulations that would require the timely identification and termination of a leak, there is no information available to make a generic assessment. Therefore, a site-specific evaluation in the Environmental Report is needed for each application for license renewal, and this issue is considered Category 2.

4.5.2 Environmental Consequences of Alternatives to the Proposed Action

Construction—For all alternatives discussed in this section, the impacts of construction on water resources would be similar. Construction-related impacts on hydrology (land clearing and impervious pavements) would alter surface drainage patterns and groundwater recharge zones. Surface water runoff over disturbed ground and material stockpiles could increase levels of dissolved and suspended solids and other contaminants. Groundwater withdrawn from onsite wells and dewatering systems could depress the water table and possibly change the direction of groundwater flow near the plant. Concrete production and wetting of ground surfaces and unpaved roadways for fugitive dust control could require substantial amounts of water. Appropriate permits, including a Clean Water Act Section 404 permit, Section 401 certification, and Section 402(p) NPDES general stormwater permit, would be required prior to construction. These impacts would apply generally to the construction phase of each of the alternatives discussed below. Differences among alternatives would depend not only on the selected technology but also on site-specific factors, which cannot be evaluated here. Discussion of such differences is outside the scope of this GEIS.

Operation—Most electrical power plants require water for cooling. As a result, fossil-fueled and nuclear power plants are generally located near large surface water bodies, including lakes, rivers, or oceans. Water cooling systems at power plants use either once-through or closed-cycle systems. Potable water can be purchased from municipalities or commercial water providers or obtained from onsite wells or a combination of the above.

Potential operational impacts to surface waters could occur from blowdown and evaporative losses in the steam cycle and cooling system and from drift of chemically treated cooling water from the cooling tower. Releases of industrial wastewaters would be controlled by an NPDES permit. The operational impacts of alternative energy technologies on land use and visual resources are presented in the following subsections.

4.5.2.1 Fossil Energy Alternatives

Operation—Fossil fuel power plants require a continuous supply of water to operate. Water demands vary greatly among technologies, ranging from a low of 3,760 gpm (14,222 L/min) for an IGCC technology without carbon capture and storage to more than 14,000 gpm (53,000 L/min) for a subcritical pulverized coal unit with carbon capture and storage. EPA estimates of raw water usage for various coal-burning technologies, normalized to a nominal generating capacity of 500 MWe, appear in Table 4.5-1. Water resources would be affected not only by water withdrawals but by reintroduction of water from steam cycle, cooling tower, and gasifier blowdown water. Hydrology would also be affected by wastewater generated by coal and exhaust-gas cleaning devices that may be operating and by other ancillary industrial activities.

Water usage is a function of the coal combustion technology, heating value of the coal being consumed, the design of the primary cooling systems (e.g., once-through versus closed-cycle, mechanical versus natural draft, dry cooling, and wet/dry hybrid cooling), and the operation of various other devices, such as gasifiers and gas-cleaning units (including flue gas desulfurization), all of which require water.

Table 4.5-1. Raw Water Usage Estimates for Fossil Fuel Electric Power Technologies

Technology[a]	Coal Rank[b]		
	Bituminous	**Sub-bituminous**	**Lignite**
IGCC	4,960 (685) [4,950][c]	5,010 (676) [5,000][c]	5,270 (700) [5,259][d]
Subcritical PC[e]	9,260 (1,050) [9,241]	9,520 (1,050) [9,501]	9,960 (1,050) [9,940]
Supercritical PC[e]	8,460 (1,050) [8,443]	8,830 (1,060) [8,812]	9,200 (1,055) [9,182]
Ultra-supercritical PC[e]	7,730 (1,050) [7,717]	7,870 (1,050) [7,857]	8,710 (1,050) [8,695]

(a) IGCC = integrated gasification combined cycle; PC = pulverized coal.
(b) Water usage expressed as lb/MWh (lb/MBtu input) [gal/min].
(c) 500-MWe (net) unit equipped with a slurry-feed gasifier.
(d) 500-MWe (net) unit equipped with a solid-feed gasifier.
(e) 500-MWe (net) unit.
Source: EPA 2006

4.5.2.2 New Nuclear Alternatives

Water resources would be affected by operation of the cooling system and by discharges of blowdown water from the cooling system and steam cycle, both of which can introduce chemical contaminants and heat to the receiving surface water body. Operation of these systems could also affect hydrology by reducing available surface water volume, altering current patterns at intake and discharge structures, altering salinity gradients, scouring and increases in sediment caused by discharges of treated cooling water, and increasing water temperature. Hydrologic impacts would vary, depending on the surface water source used for cooling as well as the cooling water system employed. Hydrology can also be affected by the plant's service water system, which provides water for turbine and reactor auxiliary equipment cooling, reactor shutdown cooling, and other services. Surface water and groundwater can also be affected by discharges authorized under permits and by accidental spills and leaks of radionuclides, chemicals, and fuels to the ground surface. Overall, impacts on water resources at a greenfield site could be significant and depend highly on local circumstances and factors such as other dependencies on the hydrologic resources. Hydrologic impacts at a brownfield site or an existing nuclear facility could also be significant, depending on whether or not the new nuclear plant could use the existing cooling water system.

4.5.2.3 Renewable Alternatives

The operational impacts of alternative energy technologies on water resources are presented in the following subsections.

Hydroelectric Energy Sources

Reservoirs could be affected by changes in water temperature and amounts of dissolved oxygen. Surface water temperatures in the reservoir could be affected when water flow is reduced. Warm water released from the top of the dam and cooler water released from the lower portions of the dam could affect river water temperatures downstream. Additionally, both low- and high-flow conditions would alter sediment transport and deposition patterns.

Geothermal

Hydrology would be affected by water consumed by the facility; the project could consume up to 6.8 ac-ft/yr (i.e., about 2.2 million gal [8,390 m^3]) of water during operation. Degradation and loss of integrity of geothermal wells could affect shallow groundwater quality through the release of contaminants. Liners installed on any surface impoundments should be sufficient to protect surface water resources from contamination by industrial fluids (including geothermal fluids) during routine operation.

Wind

No impacts on water resources are expected to result from routine operation of either onshore or offshore wind farms.

Biomass

Water demands for cooling and steam would be similar to those of fossil fuel-fired power plants. Water demand could equal evaporative water loss from cooling tower and flue gas scrubbers, and blowdown waters discharged from steam cycle and cooling water systems. Water demand could range from 3,000 to 5,000 gpm (11,400 to 18,900 L/min). Water quality would be affected by contaminants released in runoff from piles of feedstock materials, fly and bottom ash, and scrubber sludge.

Solar Thermal

There is a potential for contamination from accidental release of working fluids (heat transfer fluids) or thermal storage media (molten salts) contained in binary systems. For an advanced power tower facility operating in 2030 and using a wet mechanical cooling tower, projected water demands (i.e., consumptive use as a result of water lost to evaporation) would be about 630 gal (2.4 m^3)/MWh (EERE 1997).

4.6 Ecological Resources

4.6.1 Environmental Consequences of the Proposed Action—Continued Operations and Refurbishment

Environmental conditions at all nuclear power plants and associated transmission lines have been well established during the current licensing term. These conditions are expected to remain unchanged during the 20-year license renewal term. The following section describes the effects of continued operations and refurbishment activities on terrestrial and aquatic resources over the license renewal term.

Continued operations and refurbishment are not expected to change substantially over the license renewal term. Therefore, license renewal generally represents a continuation of current environmental stresses that have existed over many years of operation. However, due to the ever-changing nature of biological communities, the impacts of continued operation may change. These conditions are described in Sections 3.6.1 (Terrestrial Resources), 3.6.2 (Aquatic Resources), and 3.6.3 (Special Status Species and Habitats). The factors associated with continued operations and refurbishment activities that could affect these resources over the 20-year license renewal term are presented in the following sections.

4.6.1.1 Terrestrial Resources

Continued operations of the nuclear power plants during the 20-year license renewal term are expected to include operation of cooling towers, operation of once-through cooling systems and cooling ponds, management of transmission line ROWs, maintenance of site facilities, releases of gaseous and liquid effluents, and potentially, and refurbishment-related construction activities. Terrestrial habitats and wildlife would continue to be exposed to cooling tower drift; maintenance activities associated with ROWs, cooling systems, and site facilities; and chemical and radiological releases. Cooling towers and transmission lines would continue to be potential collision hazards for birds, wildlife near the site would be exposed to elevated noise levels, and refurbishment-related construction activities could result in habitat loss and disturbance of wildlife. Details regarding these impacting factors are presented in Section 3.6.1.

This section considers the following issues related to terrestrial resources:

- Effects on terrestrial resources (non-cooling system impacts) (issue was modified from the 1996 GEIS to encompass the impacts of continued operations and refurbishment);

- Exposure of terrestrial organisms to radionuclides (new issue not considered in the 1996 GEIS);

- Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds) (issue was modified and renamed from the 1996 GEIS issue, “Cooling pond impacts on terrestrial resources”);

- Cooling tower impacts on vegetation (plants with cooling towers) (consolidation of two issues from the 1996 GEIS: (1) cooling tower impacts on crops and ornamental vegetation, and (2) cooling tower impacts on native plants);

- Bird collisions with plant structures and transmission lines (consolidation of two issues in the 1996 GEIS: (1) bird collisions with cooling towers and (2) bird collision with transmission lines);

- Water use conflicts with terrestrial resources (plants with cooling ponds or cooling towers using makeup water from a river) (new issue not specifically considered in the 1996 GEIS);

- Transmission line ROW management impacts on terrestrial resources (consolidation of two issues from the 1996 GEIS: (1) power line ROW management (cutting and herbicide application) and (2) floodplains and wetland on power line ROW)). This issue includes impacts on upland plant communities; and

- Electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock) (issue from the 1996 GEIS).

Effects on Terrestrial Resources (Non-Cooling System Impacts)

Continued operations and refurbishment activities could continue to affect onsite terrestrial resources during the license renewal term at all operating nuclear power plants. Factors that could potentially result in impacts include landscape maintenance activities, stormwater management, and elevated noise levels. These impacts would, for the most part, be similar to past and ongoing impacts. The 1996 GEIS did not evaluate the impact of continued operations and maintenance on onsite biota, but this issue has been identified by the NRC for consideration in this GEIS revision on the basis of environmental reviews performed for plant-specific SEISs.

Nuclear power plant sites are typically maintained as modified habitats with lawns and other landscaped areas; however, they may also include disturbed early successional habitats or even small areas of relatively undisturbed habitat. Onsite developed areas are generally maintained by mowing and the application of herbicides or pesticides. The diversity of plant species in these areas is generally kept at a reduced level. Plant species often consist of cultivated varieties or weedy species tolerant of disturbance. Areas of the nuclear plant site outside the security fence may include natural areas, such as forests or shrublands, in various degrees of disturbance. Onsite wetlands may be affected by stormwater management. Effects may include changes in plant community characteristics, altered hydrology, decreased water quality, and sedimentation (EPA 1993, 1996; Wright et al. 2006). Impervious surfaces within the watershed generally result in increased runoff and reduced infiltration, causing changes in the frequency or duration of inundation or soil saturation and greater fluctuations in wetland water levels. Runoff may contain sediments, contaminants from road and parking surfaces, or herbicides. Erosion of wetland substrates and plants can result from increased flow velocities from impervious surfaces. Onsite wildlife near transformers or cooling towers are exposed to elevated noise levels that could disrupt behavioral patterns. Maintenance of landscaped areas generally keeps wildlife diversity lower than in surrounding habitats. Wildlife species occurring on sites within the security areas are typically limited by low habitat quality and generally include common species adapted to industrial sites.

The characteristics of terrestrial habitats and wildlife communities currently on nuclear power plant sites have generally developed in response to many years of typical operations and maintenance programs. While some may have reached a relatively stable condition, some habitats and populations of some species may have continued to change gradually over time. Operations and maintenance activities during the license renewal term are expected to be similar to current activities (see Section 2.1). Because the species and habitats present on the sites (i.e., weedy species and habitats they make up) are generally tolerant of disturbance, it is expected that continued operations during the license renewal term would maintain these habitats and wildlife communities in their current State, or maintain current trends of change.

Terrestrial habitats and wildlife could be affected by ground disturbance from refurbishment-related construction activities. Land disturbed during the construction of new independent spent fuel storage installations (ISFSIs) would range from about 2.5 to 10 ac (1 to 4 ha). Other activities may include new parking areas for plant employees, access roads, buildings, and facilities. Temporary project support areas for equipment storage, worker parking, and material laydown areas could also result in the disturbance of habitat and wildlife. In the 1996 GEIS, the NRC considered only the impacts of refurbishment on terrestrial habitats and concluded that the impacts would not necessarily be the same at all sites (i.e., a Category 2 issue) and could range from SMALL to LARGE.

Operational activities occurring in undeveloped portions of the site would affect terrestrial habitats and wildlife. Some wildlife would be displaced to nearby available habitats. However, competition would increase for many species, reducing the likelihood of survival of displaced individuals. Indirect effects could include fugitive dust, alteration of hydrology from changes in surface water flow patterns and infiltration to shallow groundwater, water quality degradation, or establishment of invasive species. Species that are more sensitive to disturbance may be displaced by more tolerant species. Affected habitats may include uplands or wetlands on or near the activity as well as wetlands within the watershed. Alterations in vegetative cover, the compaction of upland soils, or the development of impervious surfaces within the watershed generally result in more runoff and less infiltration to shallow groundwater, causing an increase or decrease in the hydrologic input to nearby wetlands (EPA 1993, 1996; Wright et al. 2006). Effects include changes in the frequency or duration of inundation or soil saturation and greater fluctuations in wetland water levels. Runoff often contains sediments, contaminants from road and parking surfaces, or herbicides used in managing ROW or site vegetation (EPA 1993, 1996; Wright et al. 2006). The erosion of wetland substrates and plants can result from increased flow velocities. Actions that result in the discharge of dredge or fill material into wetlands that are under the jurisdiction of the Clean Water Act (CWA) require a Section 404 permit from the USACE. Actions that could potentially affect threatened or endangered species would require consultation with the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the Endangered Species Act (ESA), or with State resource agencies. Rare or unique plant communities, sensitive habitats such as wetlands or rookeries, or high-quality undisturbed habitats may occur in or near potentially affected areas. Impacts on such habitats could be considered LARGE if they caused the destabilization of a resource. Impacts would be considered SMALL if only previously disturbed or other lower-quality habitats were affected.

Successful application of environmental review procedures, employed by the licensees at many of the operating nuclear plant sites, would result in the identification and avoidance of important terrestrial habitats. In addition, the application of BMPs to minimize the area affected; to control fugitive dust, runoff, and erosion from project sites; to reduce the spread of invasive nonnative plant species; and to reduce disturbance of wildlife in adjacent habitats could greatly reduce the impacts of continued operations and refurbishment activities.

Site-specific factors related to refurbishment activities may vary considerably among nuclear power plant sites. The habitats present on or in the vicinity of nuclear power plants also vary greatly. Therefore, a generic determination of potential impacts on terrestrial resources from refurbishment or other activities is not possible. Impacts on terrestrial habitats and wildlife would depend on site-specific factors, and impact assessments would need to be conducted on a site-specific basis prior to license renewal. Consistent with this finding, the NRC concluded in the 1996 GEIS that the impacts of refurbishment actions could be significant if important resources are affected, depending on site-specific conditions.

On the basis of these considerations, the NRC concludes that the impact of continued operations and refurbishment activities similar to those occurring during the current license term on terrestrial resources could be SMALL, MODERATE, or LARGE, depending on site-specific differences in the terrestrial resources present, project-specific activities, and the effectiveness of mitigation measures. The issue is therefore considered Category 2.

Exposure of Terrestrial Organisms to Radionuclides

This section addresses the issue of potential impacts of radionuclides on terrestrial organisms resulting from normal operations of a nuclear power plant during the license renewal term. This issue was not evaluated in the 1996 GEIS. However, public concerns about the impacts of radionuclides on terrestrial organisms at some nuclear power plants have led to an evaluation of the issue in this GEIS revision.

Radionuclides may be released from nuclear power plants into the environment via a number of pathways. Releases into terrestrial environments often result from deposition of small amounts of radioactive particulates released from power plant vents during normal operations. typically include krypton, xenon, and argon (which do not contain radioactive particles), tritium, isotopes of iodine, and cesium, and they may also include strontium, cobalt, and chromium. Radionuclides may also be released into the aquatic environment from the liquid effluent discharge line. Radionuclides that enter shallow groundwater from cooling ponds can be taken up by terrestrial plant species, including both upland species and wetland species, where wetlands receive groundwater discharge. Terrestrial biota may be exposed to ionizing radiation from radionuclides through direct contact with water or other media, inhalation, or ingestion of food, water, or soil.

The uptake of radionuclides from soil and water by many plant species and their incorporation into plant tissues have been well demonstrated (Bell et al. 1988; Hinton et al. 1996; Hinton et al. 1999; Hitchcock et al. 2005; Kaplan et al. 2005; Sahr et al. 2005; NCRP 2006; Pinder et al. 2006). The degree of uptake varies according to the degree to which the radionuclide binds to the sediment particles (the partition coefficient [Kd] of the nuclide and sediment constituents, such as clay particles) as well as other environmental factors, such as pH or the concentrations of other elements such as potassium (NCRP 2006). The effects on plants of chronic exposure to radionuclides range from reduced trunk growth, canopy cover, stem growth, photosynthetic capacity, seed production and germination in trees, and reduced reproductive potential in herbaceous plants, to chromosome damage as well as mortality in both groups (IAEA 1992; Real et al. 2004; Sahr et al. 2005). Growth effects have been observed at dose rates above 0.01 rad/hr (100 μGy/hr), while chromosome effects have occurred at 2.0×10^{-6} rad/hr (0.02 μGy/hr) (Real et al. 2004). Radionuclides are transferred to herbivores and subsequently to higher trophic levels, such as predators (Meyers-Schone and Walton 1990; Kelsey-Wall et al. 2005; Beresford et al. 2005; NCRP 2006).

The DOE guideline for radiation dose rates from environmental media recommends limiting the radiation dose to riparian and terrestrial mammals to less than 0.1 rad/d (0.001 Gy/d) and limiting the dose to terrestrial plants to less than 1.0 rad/d (0.01 Gy/d) (DOE 2002). These guidelines were developed on the basis of experimental evidence that negative effects would not occur at these doses. The effects of ionizing radiation on populations of terrestrial organisms have been given considerable attention in the literature. A report by the International Atomic Energy Agency (IAEA 1992) described invertebrate organisms as being less sensitive to ionizing radiation than are vertebrates. There is additional evidence indicating that some terrestrial wildlife species may be more resistant to ionizing radiation than are humans. For instance, Ulsh et al. (2000) examined the effects of cesium-137 radiation on cellular processes of wild turtles and humans. They discovered that human fibroblasts were 1.7 times more sensitive to ionizing radiation than the fibroblasts of wild turtles.

Eisler (1994) summarized studies examining the effects of ionizing radiation on aquatic and terrestrial organisms and reported that chronic doses at the minimum treatment dose of 90 rad/d (0.9 Gy/d) reduced the growth of some bird species. Few studies examine the effects of ionizing radiation on birds at doses lower than 90 rad/d (0.9 Gy/d), and none of them observed any adverse effects. For example, Zach et al. (1993) found no negative effects on the breeding performance of adults or the growth of nestling tree swallows (*Tachycineta bicolor*) at doses as low as 0.014 rad/d (1.4×10^{-4} Gy/d). Eisler (1994) also reported that an acute exposure of 1.1 rad (0.011 Gy) was demonstrably harmful to small mammals. In a summary by Real et al.

(2004), radiological dose rates as low as 1 rad/d (0.01 Gy/d) could be potentially harmful to some terrestrial plant species, although most effects were observed at doses greater than 100 rad/d (1 Gy/d). Furthermore, IAEA (1992) concluded that irradiation at chronic dose rates of 1 rad/d (0.01 Gy/d) or less are not likely to negatively affect plant populations.

Genetic effects of ionizing radiation on terrestrial biota have not been demonstrated at doses below the DOE guidelines. Turner et al. (1971) found that doses as low as 4 rad/d (0.04 Gy/d) adversely affect the reproductive capabilities of the leopard lizard (*Crotaphytus wislizenii*), and Nagasawa et al. (1990) observed chromosomal aberrations in the cells of hamsters at acute radiation doses as low as 2 rad (0.02 Gy). The European Committee on Radiation Risk (ECRR) reviewed studies concerning the effects of low-level radiation exposures on a variety of animal species. Although study details were not provided, the ECRR noted that a wide range of animal studies show juvenile mortality effects from internal irradiation, which have not been addressed by the International Commission on Radiological Protection (ICRP) or other risk agencies (ECRR 2003).

The NRC conducted a review of all operating nuclear power plants to evaluate the potential impacts of radionuclides on terrestrial biota from continued operations. Site-specific radionuclide concentrations in water, sediment, and soils were obtained from Radiological Environmental Monitoring Program (REMP) reports for 15 nuclear plants. These 15 plants were selected to represent sites with a range of radionuclide concentrations in the media, including plants with high annual worker total effective dose equivalent (TEDE) values (Tables 3.9-5 and 3.9-6) or public exposures (Tables 3.9-9, 3.9-10, and 3.9-11) for both boiling water reactors (BWRs) and pressurized water reactors (PWRs). The RESRAD-BIOTA dose evaluation model (DOE 2004e) was used to calculate estimated dose rates for terrestrial biota by using the media concentrations presented in the REMP reports (see Section D.5 in Appendix D for further details on the approach used).

Results of the RESRAD-BIOTA dose modeling are presented in Table 4.6-1, showing the total dose estimates for three different terrestrial ecological receptors: riparian animal (an animal that was assumed to spend approximately 50 percent of its time in aquatic environments and 50 percent of its time in terrestrial environments), terrestrial animal, and terrestrial plant. The maximum estimated dose rate calculated for any of the nuclear power plants is 0.0354 rad/d (3.54×10^{-4} Gy/d) (riparian animal at the Browns Ferry plant), which is below the guideline value of 0.1 rad/d (0.001 Gy/d) for a riparian animal receptor. It is unlikely that the normal operations of these power plants would have adverse effects on terrestrial biota resulting from radionuclide releases because the calculated doses are below protective guidelines and thus would not significantly affect populations.

On the basis of these calculations and a review of the available literature, the NRC concludes that the impact of routine radionuclide releases from past and current operations and

Table 4.6-1. Estimated Radiation Dose Rates to Terrestrial Ecological Receptors from Radionuclides Measured in Water, Sediment, and Soils at U.S. Nuclear Power Plants

	Sum of Total Dose (rad/d) for Receptor [(a)]			
Power Plant	**Riparian Animal**	**Terrestrial Animal**	**Terrestrial Plant**	**Source**
Arkansas Nuclear	4.62×10^{-4}	3.37×10^{-7}	1.04×10^{-7}	Entergy 2006a
Browns Ferry	3.54×10^{-2}	1.10×10^{-2}	1.03×10^{-2}	TVA 2003
Calvert Cliffs	2.90×10^{-7}	2.65×10^{-3}	2.49×10^{-4}	CEG 2003
Columbia	2.62×10^{-3}	4.45×10^{-4}	2.82×10^{-5}	Energy Northwest 2005
Comanche Peak	1.50×10^{-2}	2.89×10^{-6}	9.37×10^{-7}	TXU 2004
Cook	2.48×10^{-3}	2.22×10^{-3}	2.44×10^{-4}	IMP 2006
Hatch	2.39×10^{-3}	1.82×10^{-6}	5.19×10^{-7}	Southern Company 2003
Fort Calhoun	5.26×10^{-4}	3.41×10^{-7}	1.06×10^{-7}	OPPD 2004
Indian Point	2.30×10^{-3}	2.22×10^{-3}	2.44×10^{-4}	Entergy 2006b
Millstone	3.31×10^{-3}	2.20×10^{-3}	2.20×10^{-4}	DNC 2004
Nine Mile Point	2.40×10^{-3}	1.83×10^{-6}	5.24×10^{-7}	CEG 2004
Palisades	6.00×10^{-6}	2.89×10^{-7}	9.48×10^{-8}	NMC 2004
Point Beach	7.79×10^{-3}	2.48×10^{-2}	2.12×10^{-2}	EIML 2005
San Onofre	7.79×10^{-3}	2.48×10^{-2}	2.12×10^{-2}	SCE 2005
Vermont Yankee	7.56×10^{-3}	1.85×10^{-6}	5.30×10^{-7}	Entergy 2003

(a) Dose rates were estimated with RESRAD-BIOTA (DOE 2004e) by using site-specific radionuclide concentrations in water, sediment, and soils obtained from the REMP reports.

refurbishment activities on terrestrial biota would be SMALL for all nuclear plants and would not be expected to appreciably change during the renewal period. It is considered a Category 1 issue.

Cooling System Impacts on Terrestrial Resources (Plants with Once-Through Cooling Systems or Cooling Ponds)

Terrestrial vegetation and wildlife could be affected by the continued operation of cooling systems at nuclear power plants during the 20-year license renewal term. This issue applies to nuclear power plants with once-through cooling systems and cooling ponds typically with low levels of consumptive use. In the 1996 GEIS, the NRC evaluated the impacts to terrestrial ecology from cooling ponds but not the impacts from once-through cooling systems. Impacts of cooling ponds on terrestrial resources were considered to be SMALL for all plants that used cooling ponds and were designated as Category 1 issues in the 1996 GEIS. The impact on terrestrial resources from the operations of other cooling systems has been identified by the NRC for consideration in this GEIS revision. The impacts of cooling tower operations are considered as a separate issue elsewhere in this section.

Primary impacts of continued operation of the cooling systems at nuclear power plants include alterations of the physical environment that terrestrial organisms inhabit. Such changes to the physical environment may include increased water temperatures; humidity and fogging; contaminants in surface water or groundwater; and disturbance of wetlands from maintenance dredging of onsite cooling ponds, disposal of dredged material from such dredging, and erosion of shoreline wetlands. Unlike dredging of navigable waterways discussed in other GEIS issues, maintenance dredging of onsite cooling ponds and onsite disposal of dredged material (e.g., mud) typically do not require permits. Water temperatures in cooling ponds, canals, and reservoirs may increase as warm water effluent is discharged from the power plants. The elevated water temperatures associated with the cooling system may affect the distributions of some terrestrial plant and animal species associated with riparian or wetland communities. For example, the growth of plants along the cooling pond shoreline is restricted by the thermal effluent at the H.B. Robinson plant in South Carolina (NRC 2003b). Increased humidity and fogging around the cooling system discharge resulting from elevated water temperatures may alter the distributions of some vegetation communities. The cooling system may also transport contaminants generated during normal power plant operations to animal and plant receptors. Terrestrial biota may be exposed to contaminants released from the power plant's cooling system, either by direct contact with the cooling system effluent or through uptake from aquatic food sources near the cooling system. Terrestrial plants and wildlife associated with wetland or riparian communities along the receiving water body may be exposed, as well as wildlife that forage in these waters, such as waterfowl. In these cases, contaminants associated with the cooling system may have adverse impacts on terrestrial organisms. Maintenance dredging near cooling system intakes or outfalls may disturb wetland habitats along with accumulated sediments, and sedimentation from dredging disposal may indirectly affect wetlands. Shoreline wetlands or riparian habitats may be affected by erosion resulting from high-velocity effluent discharges or altered current patterns. The impacts of the cooling system are of concern if water temperature, humidity and fogging levels, contaminants associated within the discharged effluent, maintenance activities, or discharge flows have adverse effects on local plant and animal populations.

The NRC examined the potential impacts of the operation of nuclear power plant cooling systems on terrestrial resources during the 20-year license renewal term by reviewing published site-specific radiological effluent release (RER) reports, site environmental reports (ERs), and SEISs. For this analysis, a total of eight nuclear power plants with different types of cooling systems were investigated to determine the effects of cooling system operation on terrestrial resources. The type of cooling system that operated at each of the eight power plants reviewed, and a summary of the contaminants evaluated in the aquatic effluent, is shown in Table 4.6-2.

Contaminants investigated to be of potential concern in the liquid effluent associated with cooling systems at nuclear power plants include chlorine and other biocides, tritium, heavy metals, VOCs, oil products, and strontium. The concentrations of these contaminants have been found to be low within the liquid effluent discharged from the nuclear power plants.

Although water screening guidelines have not been established for terrestrial biota, compliance with NPDES permits should ensure that nonradioactive contaminant concentrations discharged from the cooling system are low enough to have only SMALL impacts on water quality and aquatic communities.

From a review of the 2006 RER reports for the power plants, quarterly tritium releases in liquid effluent may be as high as 1.69×10^{-5} µCi/mL. These concentrations do not exceed the public health-regulated tritium concentrations specified in 10 CFR Part 20, Appendix B, Table 2, which is set at 0.001 µCi/mL for water effluent concentrations. Tritium concentrations discharged in liquid effluent are much lower than those reported to have adverse effects on terrestrial wildlife. For example, Cahill et al. (1975) exposed rats to 1, 10, 50, or 100 µCi/mL of tritium in drinking water per day. They found that rats exposed to the higher doses (50 and 100 µCi/mL) experienced shorter life spans, whereas no adverse chronic effects were observed in rats at the two lower doses (1 and 10 µCi/mL). Therefore, the discharge of contaminants on terrestrial resources during the license renewal term is considered to be of SMALL significance.

Table 4.6-2. Contaminants Evaluated in Cooling Systems at Selected Power Plants

Power Plant	Cooling System	Contaminants	References
Dresden	Cooling lake and spray canal	Chlorine, tritium, heavy metals	NRC 2004a; Exelon 2003
Oyster Creek	Once-through cooling	Chlorine, tritium, VOCs	NRC 2007b
Palisades	Mechanical draft cooling tower	Chlorine, tritium, bromine, oil	NRC 2006d
Peach Bottom	Once-through cooling with towers	Chlorine, tritium, strontium	NRC 2003a; Exelon 2001a
Pilgrim	Once-through cooling	Chlorine, tritium, heavy metals	NRC 2007c
Turkey Point	Closed-cycle canal	Chlorine, tritium	NRC 2002b; FPL 2000
Vermont Yankee	Once-through cooling and towers	Chlorine, copper, iron, zinc	NRC 2007a
Wolf Creek	Closed-cycle cooling pond	Chlorine, tritium	WCNOC 2002; WCGS 2003

In the operation of the cooling system, contaminants (e.g., heavy metals) may be leached from condenser tubing and discharged by the power plant's cooling system. Elevated concentrations of these contaminants are toxic to aquatic and terrestrial organisms. In the past, the use of copper alloy condenser tubes in the cooling systems at the H.B. Robinson plant in South Carolina and Diablo Canyon plant in California resulted in the discharge of copper in the liquid effluent, which was observed to have adverse effects on the morphology and reproduction of resident bluegill populations at the Robinson plant (Harrison 1985), and abalone (*Haliotis* spp.) deaths were attributed to the increased copper levels discharged after a resumption of operations at Diablo Canyon (NRC 1996). Terrestrial wildlife that feed on these fish in the receiving waters could have been exposed to elevated copper levels. Also, potential reductions in populations of prey species could affect predator species. However, the replacement of the copper alloy condenser tubes with tubes made of different materials (e.g., titanium) has rectified this problem.

Thermal impacts on terrestrial habitats or wildlife exposed to elevated temperatures have not been identified at the nuclear power plants; however, as noted above, the growth of plants along portions of cooling pond shorelines may be restricted by high-temperature effluents. Temperature increases in receiving water bodies due to effluent discharges are regulated through NPDES permits to limit the extent of temperature increases for the protection of biota. In addition, because the plant communities present have been influenced by many years of facility operation, the elevated temperatures are unlikely to result in mortality of wetland and riparian plants that may be exposed to the discharges because species that are intolerant of elevated temperatures are unlikely to be growing near the outfall. The heated effluents could lengthen the growing season for wetland or riparian plant communities present. A potentially beneficial effect of the heated discharges at the Turkey Point plant in Florida has been the development of suitable habitat for the American crocodile (*Crocodylus acutus*), an established population of which occupies the cooling canal system. In addition, ice-free open water areas that provide foraging opportunities for the bald eagle (*Haliaeetus leucocephalus*) and various waterfowl species are often maintained by heated discharges during winter months at a number of nuclear plants in northern States. These benefits would be expected to continue during the license renewal term.

The impingement of waterfowl at the cooling water intakes has been observed at some nuclear plants, such as the Cook plant in Michigan, the Nine Mile Point plant in New York, and the Point Beach plant in Wisconsin. About 400 ducks, primarily lesser scaup (*Aythya affinis*), were impinged at the D.C. Cook plant in December 1991 (Mitchell and Carlson 1993); about 100 ducks, both greater scaup (*Aythya marila*) and lesser scaup, were impinged in January 2000 at the Nine Mile Point plant (NRC 2006e). At Point Beach, a number of double-crested cormorants (*Phalacrocorax auritus*) were impinged in September 1990, and 33 birds (mostly gulls) were impinged from June 2001 through December 2003 (NRC 2005b). Changes in operational procedures, such as the periodic cleaning of zebra mussels off intake structures, and changes in intake structure design, have been implemented to minimize the impacts on waterfowl. It is likely that any impingement over the license renewal term would result in only minor effects on waterfowl populations.

Groundwater quality can be degraded by contaminants present in cooling ponds and cooling canals. Deep-rooted terrestrial plants could be exposed to these contaminants. In addition, biota could be exposed to contaminants at locations of groundwater discharge, such as wetlands or riparian areas. However, as noted above, contaminant concentrations are typically very low, and any effects on terrestrial plants would be expected to be SMALL. Mitigation may also be implemented where sensitive resources could be affected. At the Turkey Point plant in Florida, for example, the flow of hypersaline groundwater from the cooling canals toward the Everglades to the west is prevented by an interceptor ditch, located along the west side of the canal system, from which groundwater inflow is extracted (NRC 2002b).

Surface water or groundwater that is withdrawn by nuclear power plants may potentially reduce the availability of water to terrestrial biota, such as those associated with wetlands or riparian areas along surface water bodies used as sources of cooling water, or those supported by groundwater discharges to wetlands or riparian areas. For once-through cooling systems, flow reductions from consumptive use generally represent a small decrease in water availability and have not resulted in water use conflicts for terrestrial resources. For example, losses due to the operation of the cooling system at the Peach Bottom plant in Pennsylvania, which operates as a once-through system with helper cooling towers, represent less than 2 percent of the minimum monthly average river flow of the cooling water source (NRC 2003a). In contrast, however, for some closed-cycle systems, consumptive water use may result in conflicts with requirements for the protection of riparian, wetland, or other communities, primarily where the nuclear plants are located on small bodies of water or small streams. Although water withdrawal rates are much lower for closed-cycle systems (which require makeup water as a result of evaporative losses) than for once-through systems, consumptive losses may be relatively high. Because of restrictions imposed at some plants on water withdrawal and consumption rates, which are protective of biotic resources, reductions in plant operations may be required under certain conditions when there are low water levels, such as during droughts. During extensive droughts, temporary impacts on riparian and wetland communities could occur.

Impacts on terrestrial biota associated with the operation of the cooling system have not been reported as a problem at any of the nuclear power plants evaluated. No adverse effects on terrestrial plants or animals have been reported as a result of increased water temperatures, fogging, humidity, or reduced habitat quality. Because of the low concentrations of contaminants within the liquid effluents associated with the cooling systems, the uptake and accumulation of contaminants in the tissues of wildlife exposed to the contaminated water or aquatic food sources are not expected to be a significant issue, and the impacts are expected to be SMALL for all plants. Potential mitigation measures would include regular monitoring of the cooling systems for water quality and measures to exclude wildlife from contaminated ponds. On the basis of these considerations, the NRC concludes that the impact of continued operation of the cooling systems on terrestrial resources would be SMALL for all nuclear plants and is considered a Category 1 issue.

Cooling Tower Impacts on Vegetation (Plants with Cooling Towers)

Continued operation of cooling towers could affect vegetation during the license renewal term. This issue applies only to operating nuclear power plants with cooling towers. The issue is a consolidation of two issues evaluated in the 1996 GEIS: (1) cooling tower impacts on crops and ornamental vegetation and (2) cooling tower impacts on native plants. Impacts of cooling tower emissions on these resources were considered to be SMALL for all plants and were designated as Category 1 issues in the 1996 GEIS.

As discussed in Section 3.6.1, terrestrial habitats in the vicinity of nuclear power plant cooling towers have been exposed to deposition of cooling tower drift particulates (including salt), deposition of water droplets on vegetation from drift, structural damage from freezing vapor plumes, and increased humidity. Drift contains small amounts of particulates that are dispersed from cooling towers over a wide area, with particulates from natural draft towers dispersing over a larger area and at a lower deposition rate than from mechanical draft towers (NRC 1996). However, most of the deposition from cooling towers occurs in relatively close proximity to the towers. Generally, deposition rates from these cooling towers have been below those that are known to result in measurable adverse impacts on plants, and no deposition effects on agricultural crops or plant communities have been observed at most of the nuclear power plants (NRC 1996). Exceptions have been observed at some nuclear plants; however, the impacts have been addressed by changes to cooling tower operations. For example, high levels of sulfate deposition, along with temporary excessive icing conditions at the Palisades plant on the southeast shoreline of Lake Michigan, resulted in the loss of about 5 ac (2 ha) of dune forest near the cooling towers and its replacement with a dense scrub-shrub community within several years of the startup of operations (NRC 2006b). These conditions were subsequently resolved by changes made to the cooling system.

Salt deposition from cooling tower drift is a potential impacting factor that can affect coastal power plants that use high-salinity water for cooling. The only such nuclear plant is the Hope Creek plant in New Jersey, which has natural draft cooling towers and withdraws cooling water from the Delaware River estuary (see Section 3.3.2 for a discussion of Hope Creek cooling tower drift emissions). High rates of deposition on plants or soil can result in injury to plants from acute effects and may result in changes to plant communities from chronic effects (Talbot 1979). Salt-tolerant species may increase in abundance, while sensitive species may decrease. Some salt-tolerant species are invasive and may become dominant in affected areas. However, no measurable effects from cooling tower drift on plant communities in the vicinity of Hope Creek have been observed (NRC 1996). The Palo Verde plant in Arizona uses cooling water with somewhat elevated salt concentrations. Studies have detected elevated levels of salt in plant leaves near the plant; however, the studies showed that no changes to native plants or crop production occurred (see Section 3.3.2 for a discussion of cooling tower drift emissions from the Palo Verde plant).

Impacts from icing have been rare, minor, and localized near nuclear power plant cooling towers and have been corrected by changes in tower operation at the plants where they occurred. For example, icing damaged oak trees adjacent to the cooling towers at the Prairie Island plant in Minnesota, changing the tree canopy structure and reducing acorn viability. Changes in tower operations eliminated the impacts (NRC 1996). Impacts from increased humidity have not been observed at nuclear power plants.

The continued operation of nuclear power plants would not be expected to result in increases in deposition rates from cooling towers or the accumulation of deposition constituents in soils. Because of the solubility of these materials, they are generally removed through precipitation. Plant communities in the vicinity of cooling towers have been exposed to many years of cooling tower operations, and are unlikely to change during the license renewal term. Any effects of icing during the renewal period would continue to be rare, minor, and localized. On the basis of these considerations, the NRC concludes that the impact of continued operation of cooling towers on plant communities would be SMALL for all nuclear plants and is considered a Category 1 issue.

Bird Collisions with Plant Structures and Transmission Lines

This section addresses the issue of avian mortality resulting from collisions of birds with natural draft cooling towers and transmission lines, within this scope of review (see Sections 3.1.1 and 3.1.6.5 in this GEIS), and other plant structures at nuclear power plants. Natural draft towers, which are tall structures (usually taller than 330 ft [100 m]), cause some mortality, whereas mechanical draft towers, which are smaller (usually shorter than 100 ft [30 m]), cause negligible mortality (NRC 1996). Because of these facts, mechanical draft towers are not addressed here. The impacts from birds colliding with cooling towers and transmission lines were evaluated by reviewing the primary literature for avian collision mortality associated with all types of man-made objects, as well as the results of monitoring studies conducted at six nuclear plants. The magnitude of the impact of the mortality caused by cooling towers is determined by examining the actual numbers and species of birds killed and comparing this mortality with the total avian mortality resulting from other man-made objects relative to bird population size.

Throughout the United States, it has been estimated that millions of birds are killed each year when they collide with man-made objects, including cooling towers, radio and television towers, buildings, vehicles, wind generation facilities, transmission lines, and numerous other objects

(Erickson et al. 2001). Many of these deaths can be considered unlawful take under the Endangered Species Act or the Migratory Bird Treaty Act. Bird mortality resulting from collisions with man-made structures is of concern if the stability of the local or migratory population of any bird species is threatened or if the reduction in numbers within any bird population significantly impairs its function within the ecosystem.

The number of collision-related bird deaths varies, depending on the type of man-made object. For example, Table 4.6-3 shows the estimated annual bird collision mortality in the United States. Collisions with buildings and windows account for the greatest number of collision mortalities annually, whereas wind generation facilities account for the least number of collision- related deaths (Table 4.6-3; Erickson et al. 2001). These estimates differ largely as a result of the density of the man-made structures in the study areas. It is estimated that more than 98 million commercial and residential buildings exist across the United States (Klem 1990; Erickson et al. 2001); compare this number with the number of wind turbines, which is less than 20,000 in 29 States (Manville 2005).

There are nearly 100,000 communication towers registered with the Federal Communications Commission (68 FR 53696 k), some of which have been observed to cause a large number of avian collision mortalities (Able 1973; Kemper 1996; Crawford and Engstrom 2001). Most of these large mortality events at communication towers occur at night during spring and fall migration periods involving songbirds that appear to become confused by tower lights (Taylor and Kershner 1986; Larkin and Frase 1988; Manville 2005). For example, a single television tower in northern Florida, Crawford and Engstrom (2001) reported more than 44,000 bird

Table 4.6-3. Estimated Annual Bird Collision Mortality in the United States

Source	Annual Mortality[a]
Vehicles[b]	60 million to 80 million
Buildings and windows[c]	98 million to 980 million
Power lines[d]	10,000 to 174 million
Communication towers[e]	4 million to 50 million
Wind generation facilities[f]	10,000 to 40,000

(a) Estimated annual mortality was extrapolated from literature reviews.
(b) Includes automobiles, trains, and airplanes.
(c) Includes buildings and attached structures such as smokestacks and windows.
(d) Includes all electric communication lines and transmission lines.
(e) Includes radio, television, cellular, microwave, and public safety towers.
(f) Includes wind turbines and supporting structures.
Source: Erickson et al. 2001

collision mortalities over a 29-year period. Communication towers involved with the most bird collisions are tall (exceeding 1,000 ft [305 m]), illuminated at night with incandescent lights, guyed, and located near wetlands and bird migration pathways (Manville 2005). During nights of heavy cloud cover or fog, the incandescent lights illuminating the communication towers may attract migrating songbirds to the towers, increasing the likelihood of collisions. Compared to communication towers, cooling towers at nuclear power plants are shorter (less than 650 ft [200 m]) and are illuminated with low-intensity light sources (1.0 ft-candle or less), such that migrating birds may not be as attracted to them, thus decreasing the likelihood of collision.

Natural draft cooling towers and transmission lines create collision hazards for migratory and local bird species. Monitoring of bird collisions has been done at several nuclear plants with natural draft cooling towers, including the Susquehanna plant on the Susquehanna River near Berwick in eastern Pennsylvania, the Davis-Besse plant on the shore of Lake Erie in north central Ohio, the Beaver Valley plant on the Ohio River in extreme western Pennsylvania, the former Trojan plant on the Columbia River in extreme northwestern Oregon, the Three Mile Island plant near Harrisburg in southeastern Pennsylvania, and the Arkansas plant on Dardanelle Lake in northwestern Arkansas. The following information regarding those plants was obtained from nuclear plant annual monitoring reports and from Temme and Jackson (1979).

At the Susquehanna plant, surveys were conducted on weekdays during the spring and fall bird migrations from 1978 through 1986. (Unit 1 began operating in 1983 and Unit 2 came online in 1985.) The plant's natural draft towers are 165-m (540-ft) tall and illuminated at the top with 480-V aircraft warning strobe lights. About 1,500 dead birds (total for all survey years, an average of 166 per year) representing 63 species were found; they had apparently collided with the cooling towers. Other birds were probably lost in the tower basin water during plant operation. Most of the birds were songbirds. Fewer collisions seemed to occur during plant operation, when cooling tower plumes and noise may have frightened birds away from the towers.

At Davis-Besse, extensive surveys for dead birds were conducted from fall 1972 to fall 1979. Early morning surveys at the 152-m-tall (499-ft-tall) cooling tower were made almost daily from mid-April to mid-June and from the first of September to late October. After the tower began operating in the fall of 1976, some dead birds were lost through the water outlets of the tower basin. A total of 1,561 dead birds were found, an average of 195 per year. The dead birds included 1,229 at the cooling tower, 224 around Unit 1 structures, and 108 at the meteorological tower. Most were night-migrating songbirds, particularly wood-warblers (family Parulidae), vireos (*Vireo* spp.), and kinglets (*Regulus* spp.). Waterfowl that were abundant in nearby marshes and ponds suffered little collision mortality. Most collision mortalities at the cooling tower occurred during years when the cooling tower was not well illuminated (1974 to spring 1978). After the completion of Unit 1 structures and installation of many safety lights around the buildings in the fall of 1978, collision mortality was significantly reduced (average of 236 per year from 1974 through 1977, 135 in 1978, and 51 in 1979). This reduction was accomplished by installing low-intensity light sources (1.0 ft-candle or less) to illuminate the cooling tower, which allowed birds to see and avoid it. It appears that the lights at nuclear plants do not confuse birds to the extent that lights on radio or TV towers sometimes do.

At Beaver Valley, surveys were conducted at the natural draft tower in the spring and fall seasons from 1974 through 1978. A total of 27 dead birds were found. At the Trojan plant, surveys were conducted weekly in 1984 and 1988 at the 499-ft-tall (152-m-tall) cooling tower, meteorological tower, switchyard, and generation building. No dead birds were found. At the 371-ft-tall (113-m-tall) cooling towers at Three Mile Island, 66 dead birds were found from 1973 through 1975. No dead birds were found at the Arkansas plant, where monitoring at the natural draft tower was done twice weekly from October 15 through April 15 in 1978–79 and 1979–80.

The available data on cooling-tower collision mortality suggest that cooling towers at nuclear power plants cause only a very small fraction of the total annual bird collision mortality from all sources. A very high percentage of all collision mortalities occur during the spring and fall bird migration periods and involve primarily songbirds migrating at night. The relatively few nuclear power plants in the United States that have natural draft towers (24 towers at operating nuclear power plants), combined with the relatively low bird mortality at individual natural draft towers, indicates that (1) bird populations are not greatly affected by collisions with nuclear power plant cooling towers and (2) the contribution of cooling towers to the cumulative effects of bird collision mortalities is very small. Mechanical draft cooling towers, which are not nearly as tall as natural draft towers, pose little risk to migrating birds.

Because the frequency of avian mortality resulting from collisions with cooling towers is small for any species, it is unlikely that the losses would threaten the stability of local migratory bird populations or result in a noticeable impairment of the function of a species within local ecosystems. There is no reason to believe that the annual mortality rate resulting from collision of birds with any cooling tower would be different during the license renewal term. Mitigation measures may include illuminating the natural draft cooling towers at night with low-intensity lights so birds can see the towers and avoid collisions. Because cooling towers represent only a small part of total bird collision mortality, it is not expected that there will be any incremental impact on bird populations from cooling tower collision mortality as a result of license renewal. The impact from bird collisions with cooling towers during the license renewal term was considered to be SMALL for all nuclear plants and was designated as a Category 1 issue in the 1996 GEIS. No new information has been identified in the plant-specific SEISs prepared to date or the literature that would alter that conclusion.

The potential for birds to collide with transmission lines depends on a number of factors, such as bird species, migration behavior, and location and physical characteristics of the transmission line (Bevanger 1988; Janss 2000; Manville 2005). Larger-bodied bird species such as raptors are more likely to collide with transmission lines (Harness and Wilson 2001; Manville 2005), whereas smaller-bodied birds such as migrating songbirds are more likely to collide with towers (Temme and Jackson 1979). This difference is most likely the result of differences in the behavior of raptors and songbirds. Raptors are known to use utility structures as perch locations and nest sites more often than do songbirds (Blue 1996; Manville 2005), whereas nocturnal migrating songbirds may become confused by the lights on communication towers (Crawford and Engstrom 2001). Lights are not a contributing factor in bird collisions at transmission lines because lights are not generally used to mark transmission lines.

It is unknown to what extent bird populations are negatively affected by deaths caused by collisions with transmission lines. Generally, bird mortality resulting from collisions with transmission lines has appeared to be only a small fraction of total mortality; therefore, it has not been considered to have significant population impacts (Stout and Cornwell 1976; Banks 1979). However, rare, threatened, or endangered species may be affected by transmission lines, particularly if the lines pass through areas where such species are concentrated (Sergio et al. 2004; Sundar and Choudhury 2005). There are no reports of relatively high collision mortality occurring at the transmission lines associated with nuclear power plants in the United States. As described in Section 3.1.6.5 and further in 3.1.1, in-scope transmission lines include only those lines that connect the plant to the first substation that feeds into the regional power distribution system. This substation is frequently, but not always, located on the plant property. The length of transmission lines associated with nuclear plants is considerably less than the total 500,000 mi (800,000 km) of transmission lines estimated within the United States (Manville 2005). Therefore, transmission lines associated with nuclear power plants are likely responsible for only a small fraction of total bird collision mortality.

Because the literature does not indicate there is a significant impact from collision mortality on overall species populations and because there are no known instances in which nuclear plant transmission lines have affected local bird populations, it is not expected that the mortality resulting from bird collisions with transmission lines associated with nuclear plants and an additional 20 years of plant operation would cause long-term reductions in bird populations.

The impact of bird collisions with transmission lines during the license renewal term was considered to be SMALL for all plants and was designated as a Category 1 issue in the 1996 GEIS. No new information was identified in the site-specific SEISs prepared to date or the literature that would alter that conclusion. On the basis of these considerations, the NRC concludes that the impact of bird collisions with plant structures and transmission lines during the license renewal term would be SMALL for all nuclear plants and remains a Category 1 issue.

Water Use Conflicts with Terrestrial Resources (Plants with Cooling Ponds or Cooling Towers Using Makeup Water from a River)

In the 1996 GEIS, water use conflicts included ecological impacts on aquatic and riparian communities. The NRC separated out the ecological impacts in this revised GEIS to specifically address the effects of water use conflict on terrestrial resources in riparian communities. This new issue specifically applies to nuclear power plants with cooling ponds or cooling towers, typically with high levels of consumptive use and that use makeup water from a river. Water use conflicts with terrestrial resources in riparian communities could occur when water that supports these resources is diminished either because of decreased availability due to droughts; increased water demand for agricultural, municipal, or industrial usage; or a combination of such factors. For example, Wolf Creek uses Coffee County Lake for cooling (NRC 2008a). Makeup water for the lake is withdrawn from the Neosho River downstream of John Redmond Reservoir. The Neosho River is a small river with especially low water flow during drought conditions. The riparian communities downstream of this reservoir may be affected by the plant’s water use during periods when the lake level is low and makeup water is obtained from the Neosho River. For the Wolf Creek plant, the water use conflict impact is SMALL to MODERATE and a site-specific condition. For future license renewals, the potential range of impact levels at plants with cooling ponds or cooling towers using makeup water from a river cannot be determined at this time. The NRC concludes that the impact of water use conflicts with riparian communities is a plant-specific Category 2 issue.

Transmission Line ROW Management Impacts on Terrestrial Resources

This section evaluates the extent to which plant communities and wildlife populations could be affected by transmission line ROW management during the license renewal term at all nuclear power plants. This issue is a consolidation of two issues that were evaluated in the 1996 GEIS: (1) power line ROW management (cutting and herbicide application) and (2) floodplains and wetland on power line ROW. Impacts on these resources were considered to be SMALL for all plants and were designated as Category 1 issues in the 1996 GEIS. As described in Section 3.1.6.5 and further in 3.1.1, in-scope transmission lines include only those lines that connect the plant to the first substation that feeds into the regional power distribution system. This substation is frequently, but not always, located on the plant property.

Generally, ROW management involves clearcutting, selective cutting of tall woody vegetation, mowing, or herbicide application. These activities alter the physical features of vegetation communities by reducing vegetation height, density, and species diversity, which may impact wildlife populations inhabiting those areas. The cutting of woody vegetation is usually not needed in grassland, desert, or shrub habitats, so associated impacts are not an issue there. Habitat quality in the ROW and nearby areas may be affected, and ROW management may affect local wildlife populations. Data on the effects of maintenance of transmission line ROWs specifically associated with nuclear power plants are not available, but the literature applies to such transmission lines because the methods used to maintain transmission line ROWs are similar for any transmission line ROW at any facility.

Plant communities are affected by the presence of maintained ROWs as well as other ongoing maintenance activities. The principal impacts associated with transmission line ROWs occur as a result of the initial clearing activities during transmission line installation. During installation, forested upland and wetland habitats in ROWs are typically converted to scrub-shrub communities, herbaceous upland, or emergent wetland types when trees are removed. Effects are less extensive where ROWs are established in grassland, desert, or shrub habitats. ROW effects extend beyond the area of direct disturbance. Transmission line ROWs established in otherwise undeveloped areas contribute to habitat fragmentation and affect the distribution of species in undisturbed areas along the corridors. The effects of habitat fragmentation associated with clearings and the creation of edges may continue to develop over a considerable period of time, since some species are lost while others become established (Saunders et al. 1991). Clearings in wooded areas tend to contribute to an increase in deer populations and increased access to forest interior areas (Alverson et al. 1988). The gradual loss of some plant species from these areas due to browsing may extend over many decades.

The operation of heavy equipment during ROW maintenance activities can result in soil compaction, affecting the establishment of some native plant species. ROW corridors occasionally provide a route for the introduction or expansion of invasive species populations into new areas. Significant changes in vegetation cover, such as removal of the tree canopy, and compaction of upland soils within the watershed of a wetland generally result in increased runoff and reduced infiltration to shallow groundwater, causing an increase or decrease in hydrologic input to nearby wetlands (EPA 1993, 1996; Wright et al. 2006). Effects include changes in the frequency or duration of inundation or soil saturation and greater fluctuations in wetland water levels. Runoff often contains sediments, contaminants from road and parking surfaces, or herbicides used in ROW or site vegetation management. Erosion of wetland substrates and plants can result from increased flow velocities that result from the changes in runoff and surface drainage patterns.

The presence of the ROWs would continue to affect the habitats within and adjacent to the transmission line corridors during the license renewal term; there would be more light and less soil moisture than found in undisturbed habitats. The plant communities that became established during the years of the initial operating license would generally remain altered communities, with a different species composition and community structure than undisturbed habitats. In many areas, ROW management would prevent the development of mature plant communities. Plant species that are typically associated with high-quality, undisturbed native habitats and are intolerant of disturbed conditions would generally continue to be excluded from ROWs. Although species diversity may be high in these disturbed habitats, many of the species may be common or weedy native species or non-natives. However, in some areas, rare or protected species that require open canopies, such as the golden sedge (*Carex lutea*), Cooley's meadowrue (*Thalictrum cooleyi*), and rough-leaf loosestrife (*Lysimachia asperulaefolia*), which occur within the Brunswick Steam Electric Plant ROWs in North Carolina, would continue to occur under the conditions existing within the ROWs. Invasive upland or wetland species that became established within the ROWs during the initial operating license would continue to exclude native species and reduce species diversity (BPA 2000). Invasive species populations may continue to expand unless aggressive management efforts are implemented.

Plant communities in and along ROWs are generally maintained in a modified condition for safe and efficient operation of the transmission lines. To protect the electric conductors, ROW management typically includes the periodic cutting of tall trees and application of herbicides. Tree cutting is a minor management activity in regions where tree growth in ROWs is limited, such as in grasslands, desert, or shrubland areas. Mowing is also frequently used as a management method to control the growth of woody species and promote the establishment of grassland or other herbaceous habitat types. Management activities and transmission line repair occasionally result in the erosion of exposed soils where vegetation has been removed or where soils are disturbed by equipment. Management activities that result in the disturbance, compaction, or exposure of soils may promote the establishment of invasive species (BPA 2000). Erosion of upland soils may result in sedimentation or increased turbidity in wetlands within the watershed. Herbicides used to manage undesirable species may drift onto nontarget species or affect wetland communities through runoff from treated areas (BLM 2007). The operation of heavy equipment in wetlands during ROW maintenance or transmission line repair can damage or compact wetland soils and vegetation.

Many of the nuclear power plants incorporate mitigation into their ROW management plans to protect wetlands or other sensitive or high-quality habitats. For example, within the ROWs of the Millstone plant in Connecticut, precautions are taken to protect and promote quality habitats. Herbicide use is prohibited within 10 ft of wetlands or surface water, and mowing is conducted only from November through April to protect saturated soils and minimize loss of fruit and seeds (NRC 2005c). ROW maintenance practices used at the Brunswick plant in North Carolina, such as methods of herbicide use, are designed to preserve and protect rare and listed plant species and sensitive natural areas known to occur within the ROWs. Established procedures are in place to protect rare and listed plant species if they are encountered by maintenance crews (NRC 2006b). At the Browns Ferry plant in Alabama, field studies are conducted to inventory and protect listed plant species and sensitive habitats. Species populations are monitored, and habitats are managed and maintained. In the most sensitive areas, vehicles and equipment are prohibited, and all vegetation clearing is done by hand (NRC 2005d).

Most data on the impacts of transmission line ROWs on wildlife are for relatively moist areas of the United States where vegetation growth is rapid and vegetation must be controlled to prevent its interference with the transmission lines. In arid regions, little or no vegetation control is required, and the potential effects on wildlife are small. Potential effects are also small where lines cross croplands, because no vegetation management is required. The following discussion is therefore applicable primarily to forested regions where the utility must control vegetation on transmission line ROWs.

The maintenance of a transmission line ROW could directly affect wildlife as the result of (1) continued habitat loss or alteration; (2) displacement due to noise during maintenance activities; (3) mortality from maintenance equipment, conductors, or wires; (4) reduced mobility of some species, such as amphibians, across the cleared ROW; and (5) toxicity from herbicide or fuel spills. ROW creation establishes, and maintenance activities maintain, a new habitat type that divides a pre-existing and usually much larger habitat type, such as a forest (Yahner et al. 2004). The increased amount of edge along the boundary of the two habitats may affect wildlife by (1) increasing rates of predation among nesting birds, (2) restricting wildlife dispersal and migration patterns, (3) negatively affecting wildlife species that require large undisturbed areas, or (4) increasing local wildlife abundance and diversity.

Many studies identify the potential effects of ROW maintenance on wildlife populations. Transmission line ROWs may represent a barrier for species, such as large mammalian carnivores, that require large tracts of contiguous forested habitat (Crooks 2002). ROW maintenance may also have negative effects on smaller, less mobile wildlife species. For example, studies have shown that some amphibian species have difficulty crossing disturbed habitat and may experience increased rates of mortality as a result of physiological stress (Gibbs 1998; Rothermel 2004).

Traditionally, habitat edges have been considered to be beneficial to wildlife because species diversity is usually greater there (Yahner 1988). However, some species such as neotropical migrating songbirds that prefer interior forest habitat may be adversely affected by the increase in edge habitat associated with ROW clearings. These species require large blocks of forest for successful reproduction and survival (Wilcove 1988). Studies have found that nests of these bird species placed near edges are more likely to fail as a result of predation or nest parasitism than nests located near the forest interior (Paton 1994; Robinson et al. 1995). This failure is often due to an increase in the abundance of predators (e.g., skunks and raccoons) and nest parasites (e.g., brown-headed cowbirds [*Molothrus ater*] that lay their eggs in the nests of other birds), which are capable of proliferating in disturbed areas and edge habitats (Evans and Gates 1997; Crooks and Soulé 1999). Increased predation and nest parasitism rates along edge habitats have reduced the populations of some neotropical bird species to the point where they have become locally extinct (Crooks and Soulé 1999).

Numerous studies indicate that wildlife populations can benefit from ROW management. Ongoing research on the effects of ROW management on wildlife has been conducted for more than 50 years at the State Game Lands 33 Research Project in Pennsylvania (Yahner 2004). Results of the studies conducted at that site indicate that long-term management of the ROW may provide an essential food source and cover habitat for insects, amphibians and reptiles, numerous bird species, and mammals such as black bear (*Ursus americanus*) and white-tailed deer (*Odocoileus virginianus*). Even species of concern, such as neotropical migrant birds, have been commonly observed using the brushy habitats provided by the ROW. Yahner et al. (2002, 2004) found that herbicide treatments in the ROW did not have any adverse effects on the nesting success of neotropical migrating bird species like the eastern towhee (*Pipilo erythrophthalmus*). King and Byers (2002) discovered that songbird nesting success was greater within the brushy ROW habitat than in nearby vegetation communities.

In a study of rodent populations in Oregon, Wolff et al. (1997) found higher densities of gray-tailed voles (*Microtus canicaudus*) in disturbed open habitats than in other habitats. They also found no effect of habitat disturbance on vole survival, reproductive success, or population size. Johnson et al. (1979) found that the diversity of small mammals was greater in ROW habitats than in adjacent forest habitats. There is also evidence that ROW maintenance can provide suitable habitat for some important insect populations, such as butterflies (Bramble et al. 1999). Thus, the management of ROW habitats may provide suitable habitat for a number of wildlife species, including some sensitive species such as neotropical migrant songbirds.

An important aspect of ROW management is the consideration of management strategies that limit the adverse effects on wildlife species. Herbicides are generally not highly toxic to wildlife when they are properly applied for ROW management. Therefore, toxic effects of herbicides on wildlife are generally of little concern to wildlife biologists or wildlife managers. Of the papers reviewed for this analysis, none expressed serious concern about toxic effects. In fact, some management techniques using herbicides have been proposed to maintain the function of the ROW and maximize the amount of suitable habitat for wildlife species. Yahner et al. (2002) proposed a phased approach to control the growth of undesirable plants, such as large trees, and maintain an early successional shrub-like plant community along the ROW. This objective could be accomplished through a combination of mechanical treatments (e.g., mowing) and selective herbicide applications. This approach could minimize the costs associated with vegetation management along a ROW and might be an important conservation tool for numerous wildlife species (Marshall and Vandruff 2002; Yahner et al. 2002).

The overall impact of transmission line ROW areas appears to be neither significantly adverse nor significantly beneficial. The consensus among wildlife biologists appears to be that although the initial habitat destruction associated with ROW clearing can have numerous consequences on wildlife populations, the proper management of transmission line ROW areas does not have significant adverse impacts on current wildlife populations, and ROW management can provide valuable wildlife habitats. Of the papers reviewed for this evaluation, none identified any significant impact of transmission line corridors on wildlife. The evidence supports a conclusion that continued ROW management during the license renewal term will not lower habitat quality or cause significant changes in wildlife populations in the surrounding habitat. On the basis of these considerations, the NRC concludes that the impact of continued transmission line ROW management on terrestrial resources is SMALL for all nuclear plants and remains a Category 1 issue.

Electromagnetic Fields on Flora and Fauna (Plants, Agricultural Crops, Honeybees, Wildlife, Livestock)

As described in Section 3.1.6.5 and further in 3.1.1, in-scope transmission lines include only those lines that connect the plant to the first substation that feeds into the regional power distribution system. This substation is frequently, but not always, located on the plant property. The effects of electromagnetic fields on terrestrial biota are considered to be of SMALL significance if the overall health, productivity, and reproduction of individual species appear unaffected.

The EMFs produced by operating transmission lines up to 1,100 kV have not been reported to have any biologically or economically significant impact on plants, wildlife, agricultural crops, or livestock (Lee et al. 1989; Miller 1983). Areas under and in the vicinity of the lines have been studied numerous times. Vegetation, foliar damage due to EMF-induced corona at leaf margins, agricultural crop production, wildlife population abundance, livestock production, and potential livestock avoidance of the lines have been investigated. Also, many laboratory experiments with plants and laboratory animals have been conducted, often using electric fields much stronger than those occurring under transmission lines.

Plants—Studies have shown that minor damage to plant foliage and buds can occur in the vicinity of strong electric fields. For example, tree foliage and buds that are close to transmission lines can be damaged and upward or outward growth of branches can be reduced. Damage typically occurs only to the tips and margins of leaves in the uppermost plant parts that are the closest to the lines. The damage in the form of a leaf burn is most prevalent on small pointed leaves and is similar to leaf damage that might occur as a result of drought or other environmental stresses. The damage generally does not interfere with overall plant growth (Miller 1983).

The damage is thought to result from heating caused by induced corona at the leaf tips and margins. The electric field is greatly focused by leaf points or marginal teeth, thus increasing its strength to the point that corona (Section 4.6.1.3) occurs. Night-vision instruments have shown this corona as a glow of light concentrated at leaf tips and margins. The damage apparently does not extend to lower levels of the plant because the electric field weakens with distance from the lines and because the upper plant parts shield the lower parts from the electric field.

In one experiment under an 1,100-kV prototype line, the upward growth of alder and Douglas fir trees was reduced by this damage, with the result that the crowns of the trees became somewhat flattened on top and the overall crown developed a broader appearance than usual (Rogers et al. 1984). The growth of the lower parts of the trees and of lower-growing plants such as pasture grass, barley, and peas appeared unaffected (Rogers and Hinds 1983). In another experiment, 50-kV/m fields had no apparent effect on corn germination or the growth of corn seedlings; and the growth of corn, bluegrass, and alfalfa apparently was not affected by fields of 25–50 kV even though minor damage occurred to the outer fringes of the uppermost leaves (Bankoske et al. 1976). Germination of sunflower seeds in a 5-kV/m electric field was reduced by about 5 percent in some cases [4 out of 11 replicates (Marino et al. 1983)]. An experiment with several species of agricultural plants found that a maximum of about 1 percent of the total plant tissue was damaged by exposing the plants to 50-kV/m fields (Poznaniak and Reed 1978).

Lee et al. (1989) reviewed several papers reporting studies in Indiana, Tennessee, and Arkansas. The productivity of corn and other crop plants was not affected by electric fields of 12 to 16 kV/m under a 765-kV line and a UHV test line in Indiana, although plants under the larger line suffered some leaf tip damage from induced corona. Corn production in Tennessee may have been reduced by electric fields up to 8.5 kV/m, but the authors indicated the results were inconclusive. An Arkansas study found normal yields of rice and soybeans, but a 15 percent reduced yield of cotton beneath a 500-kV line (see Section 4.3.1.1). The researchers could not determine whether the reduced cotton yield resulted from electric field or ineffective aerial application of agricultural chemicals beneath the line.

Honeybees—Several studies have shown that honeybees in hives under transmission lines are affected by EMF (Greenburg et al. 1985; Rogers and Hinds 1983; Warren et al. 1981). Adverse effects include increased propolis (a reddish resinous cement) production, reduced growth, greater irritability, and increased mortality. These effects can be greatly reduced by shielding the hives with a grounded metal screen or by moving the hives away from the lines (Rogers and Hinds 1983; Lee 1980). Bindokas et al. (1988) showed that these impacts were not caused by direct effects of the electric fields on the bees but by voltage buildup and electric currents within the hives and the resultant shocks to bees. Bees kept in moisture-free nonconductive conditions were not adversely affected, even in electric fields as strong as 100 kV/m.

Wildlife and Livestock—Chronic exposure to EMF is experienced by small birds and mammals that primarily inhabit ROW corridors and by birds (primarily raptors) that nest in transmission line towers. EMF exposures to larger animals and livestock are usually relatively brief because these animals inhabit relatively large areas instead of small areas beneath the lines. Exposures occur as these larger animals pass beneath the lines or as birds fly by the lines.

The voluminous literature on population studies of small bird and mammal species in transmission line corridors (presented earlier in this section) has expressed virtually no concern for possible impacts of EMFs. These species apparently thrive underneath the lines, where their abundance appears to depend on habitat quality rather than on the strength of the electric fields to which they are exposed or the size of the line. For example, the density of breeding birds under 500-kV lines in eastern Tennessee is greater than that in adjacent forests (Kroodsma 1984, 1987) and appears to be greater than bird density in most grassland habitats or agricultural fields. Also, the density of small mammal populations near these lines appears to depend on habitat type rather than on the presence of the lines (Schreiber et al. 1976). A Minnesota study of a 500-kV line found little evidence of either a positive or negative effect of the power line on bird populations (Niemi and Hanowski 1984). Bird and small mammal populations under an 1,100-kV line in Oregon were also apparently unaffected by line operations (Rogers and Hinds 1983). Habitat use by elk in western Montana was apparently unaffected by operation of a 500-kV line, as the elk used habitats along the power line in proportion to their availability (Canfield 1988).

Raptors, ravens, and some water bird species frequently nest and perch on transmission line towers, particularly in grassland areas where other suitable nest sites are lacking. Thus, the birds are able to use habitats without suitable nest sites—habitats that they otherwise would not have used (Gilmer and Stewart 1983; Williams and Colson 1989). On high-voltage lines supported by metal lattice towers, the birds usually nest on the top (bridge) of the tower where the strength of the electric field is minimal (e.g., 5 kV/m or less) (Lee 1980). Lee found 80 percent of 110 nests on towers to be located on the tower bridge and cited previous studies that showed similar results.

The success of these tower nests in producing young appears to be no different from nests located in areas not exposed to EMF. In central North Dakota, 113 ferruginous hawk nests in high-voltage transmission line towers (18 percent of a total of 628 nests found) had a higher success rate (87 percent) than nests in other locations (however, a hail storm that missed the lines reduced the success of some other nests). The number of fledglings per occupied nest was 2.8 for ground nests (which were larger than tower or tree nests), 2.6 for tower nests, 2.3 for haystack nests, and 2.0 for tree nests (Gilmer and Stewart 1983). In Idaho, Steenhof et al. (1993) studied nesting success of ravens and raptors on a 370-mile (576-km) segment of 500-kV transmission line constructed in 1981. From 1981 through 1989 (the last year reported by Steenhof et al. 1993), the numbers of these species nesting on transmission towers increased to 133 pairs, including roughly 64 percent common ravens, 21 percent red-tailed hawks, 9 percent ferruginous hawks, 6 percent golden eagles, and 0.3 percent great horned owls. Nesting success of these birds averaged 65 percent to 86 percent and was similar to or better than that of the same species nesting on other structures. Lee (1980) reported finding 110 hawk and raven nests on 260 miles (418 km) of 230-kV and 500-kV lines of the Bonneville Power Administration. Although the success of these nests was not monitored, the author reported that, based on a literature review, it was unlikely that nesting would be adversely affected by EMF found in most locations in transmission line towers.

Livestock in both field and laboratory studies have shown no significant impacts when exposed to EMF. Lee et al. (1989) reviewed about 10 reports on effects of transmission lines on livestock in the United States and Sweden. These studies found no evidence that the growth, production, or behavior of beef and dairy cattle, sheep, hogs, or horses were affected by EMFs. The studies involved 11 farms along a 765-kV line in Indiana, 55 dairy farms near 765-kV lines in Ohio, 36 herds of cattle near 400-kV lines in Sweden, a mail survey of 106 farms in Sweden, a study of fertility of 58 cows under a 400-kV line in Sweden compared with 58 in a control area, 30 swine raised beneath a 345-kV line in Iowa compared with 30 raised in a control area, and cattle behavior under an 1,100-kV prototype line in Oregon. Cattle under the 1,100-kV test line in Oregon were startled by the first occurrence of corona noise when the line was re-energized after a reactor shutdown period (Rogers and Hinds 1983). From 1977 through 1981, grazing of cattle in pasture under the line appeared to be unaffected by line operation. In 1980–1981, the cattle spent more time near the line during periods when it was de-energized than when it was operating, but spent an increasing amount of time under the line when it was operating as the growing season progressed (Rogers and Hinds 1983).

In the Indiana study (Amstutz and Miller 1980), performance of livestock frequently under a 765-kV line on 11 farms was studied during a 2-year period (1977–1979; 9 farms participated for the full 2 years). Animals included 10 horses, 55 sheep, 149 beef cattle, 337 hogs, and 429 dairy cattle. Maximum field voltage levels recorded near ground level were about 9.1 kV/m. General health, behavior, and performance of the animals were not affected by the transmission line EMF.

In the Swedish study of cow fertility, 58 heifers were exposed to a 400-kV, 50-Hz transmission line from June to mid-October 1985 (Algers and Hultgren 1987). The length of exposure was 15 to 20 times longer than the average exposure per year for Swedish dairy herds exposed to 400-kV lines. No effects were observed on the frequency of malformations, the length or variation of the estrous cycle, the mid-cycle plasma progesterone level, the intensity of estrus, the number of inseminations per pregnancy, the overall conception rate, or the fetal viability. Previous studies of cattle showed no significant effects of EMFs on reproduction.

Conclusion—No significant impacts of EMFs on terrestrial biota have been identified. Although foliage very close to lines can be damaged, the overall productivity and reproduction of native and agricultural plants appear unaffected. Also, no evidence suggests significant impacts on individual animals or wildlife populations that are chronically exposed to EMFs under transmission lines or in the towers. Livestock behavior and production also appear unaffected by line operation. Therefore, the potential impact of EMFs on terrestrial biota is expected to be of SMALL significance for all plants. The only potential mitigation would be to exclude plants and animals from the right of way, a measure with very severe impacts of its own. However, because the impact is of small significance and because mitigation measures could create additional environmental impacts and would be costly, no mitigation measures beyond those implemented during the current term license would be warranted. This remains a Category 1 issue.

4.6.1.2 Aquatic Resources

Continued operations of the nuclear power plants during the 20-year license renewal term includes the operation of the cooling system (once-through, cooling ponds, or cooling towers), transmission line ROW maintenance, releases of gaseous and liquid effluents, facility maintenance, and refurbishment-related construction activities. Aquatic organisms would continue to be subject to impingement, entrainment, thermal discharges, chemical and radiological contaminants, and erosion and sedimentation. This section considers eleven issues concerning impacts of the proposed action on aquatic resources:

- Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds) (consolidation of two issues from the 1996 GEIS: (1) entrainment of fish and shellfish in early life stages and (2) impingement of fish and shellfish (for plants with once-through cooling and cooling pond heat dissipation systems)).

- Impingement and entrainment of aquatic organisms (plants with cooling towers) (consolidation of two issues from the 1996 GEIS: (1) entrainment of fish and shellfish in early life stages and (2) impingement of fish and shellfish (for plants with cooling tower-based heat dissipation systems)).

- Entrainment of phytoplankton and zooplankton (all plants) (issue in the 1996 GEIS);

- Thermal impacts on aquatic organisms (plants with once-through cooling systems or cooling ponds) (issue was modified and renamed from the 1996 GEIS issue, “Heat shock (for plants with once-through and cooling pond heat dissipation systems)”);

- Thermal impacts on aquatic organisms (plants with cooling towers) (issue was modified and renamed from the 1996 GEIS issue, “Heat shock (for plants with cooling-tower-based heat dissipation systems)”);

- Infrequently reported thermal impacts (all plants) (consolidation of five issues from the 1996 GEIS: (1) cold shock, (2) thermal plume barrier to migrating fish, (3) distribution of aquatic organisms, (4) premature emergence of aquatic insects; and (5) stimulation of nuisance organisms (e.g., shipworms));

- Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication (consolidation of three issues from the 1996 GEIS: (1) eutrophication, (2) gas supersaturation (gas bubble disease), and (3) low dissolved oxygen in the discharge);
- Effects of nonradiological contaminants on aquatic organisms (issue was modified and renamed from the 1996 GEIS issue, accumulation of contaminants in sediments or biota, to include contaminant effects other than just accumulation);
- Exposure of aquatic organisms to radionuclides (new issue not considered in the 1996 GEIS);
- Effects of dredging on aquatic organisms (new issue not considered in the 1996 GEIS);
- Water use conflicts with aquatic resources (plants with cooling ponds or cooling towers using makeup water from a river) (new issue not considered in the 1996 GEIS);
- Effects on aquatic resources (non-cooling system impacts) (issue was modified and renamed from the 1996 GEIS issue, "Refurbishment," to include non-refurbishment impacts);
- Impacts of transmission line ROW management on aquatic resources (new issue not considered in the 1996 GEIS);
- Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses (issue in the 1996 GEIS).

Overview of Impingement and Entrainment

Impingement occurs when organisms are held against the intake screen or netting placed within intake canals. Most impingement involves fish and shellfish. Table 4.6-4 lists some of the fish species commonly impinged at power plants. At some nuclear power plants, other vertebrate species may also be impinged on the traveling screens or on intake netting placed within intake canals. These include five species of sea turtle: loggerhead (*Caretta caretta*), green (*Chelonia mydas*), Kemp's

Impingement

Impingement is the entrapment of all life stages of fish and shellfish on the outer part of an intake structure or against a screening device during periods of water withdrawal (40 CFR 125.83).

Entrainment

Entrainment is incorporation of all life stages of fish and shellfish with intake water flow entering and passing through a cooling-water intake structure and into a cooling water system (40 CFR 125.83).

Table 4.6-4. Fish Species Commonly Impinged or Entrained at Power Plants

Ecosystem Type	Fish Species
Rivers	Alewife (*Alosa pseudoharengus*)
	Gizzard shad (*Dorosoma cepedianum*)
	Common carp (*Cyprinus carpio*)
	White bass (*Morone chrysops*)
	Sunfish (*Lepomis* spp.)
	Crappie (*Pomoxis* spp.)
	Yellow perch (*Perca flavescens*)
	Freshwater drum (*Aplodinotus grunniens*)
Great Lakes	Alewife (*Alosa pseudoharengus*)
	Gizzard shad (*Dorosoma cepedianum*)
	Yellow perch (*Perca flavescens*)
	Rainbow smelt (*Osmerus mordax*)
Estuaries	Bay anchovy (*Anchoa mitchilli*)
	Tautog (*Tautoga onitis*)
	Atlantic menhaden (*Brevoortia tyrannus*)
	Gulf menhaden (*Brevoortia patronus*)
	Winter flounder (*Pleuronectes americanus*)
	Weakfish (*Cynoscion regalis*)
Oceans	Bay anchovy (*Anchoa mitchilli*)
	Striped anchovy (*Anchoa hepsetus*)
	Silver perch (*Bairdiella chrysura*)
	Cunner (*Tautogolabrus adspersus*)
	Scaled sardine (*Harengula jaquana*)
	Queenfish (*Seriphus politus*)

ridley (*Lepidochelys kempi*), leatherback (*Dermochelys coriacea*), and hawksbill (*Eretmochelys imbricata*). Impingement of these sea turtles has occurred at the Diablo Canyon and San Onofre plants on the Pacific coast; at the Salem, Oyster Creek, Brunswick, and St. Lucie plants on the Atlantic coast; and at the Crystal River plant on the Gulf coast on the either Atlantic and Gulf of Mexico coasts or east coast (Gunter et al. 2001). Waterfowl have also been impinged at several plants; examples are double-crested cormorants (*Phalacrocorax auritus*) at Point Beach plant in Wisconsin (NRC 2005b), lesser scaup (*Aythya affinis*) at Cook in Michigan (Mitchell and Carlson 1993), and lesser scaup and greater scaup (*A. marila*) at Nine Mile Point in New York (NRC 2006d). Isolated incidents of impingement or other impacts from power plants have been reported for other vertebrates, such as the American crocodile (*Crocodylus acutus*) at Turkey Point in Florida and the West Indian manatee (*Trichechus manatus*) at Turkey Point and St. Lucie in Florida (Gunter et al. 2001). Small numbers of harbor (*Phoca vitulina*), gray (*Halichoerus grypus*), harp (*Pagophilus groenlandicus*), and hooded (*Cystophora cristata*) seals have been impinged at Seabrook in New Hampshire (67 FR 61). Impingement impacts are expected to continue during the license renewal term. The impacts of impingement are different for once-through and closed-cycle cooling systems and are therefore discussed separately below.

Entrainment occurs when organisms pass through the intake screens and travel through the condenser cooling system. Aquatic organisms typically entrained include ichthyoplankton (fish eggs and larvae), larval stages of shellfish and other macroinvertebrates, zooplankton, and phytoplankton. Juveniles and adults of some species may also be entrained if they are small enough to pass through the intake screen openings, which are commonly 0.38 in. (1 cm) at the widest point. Table 4.6-4 lists fish species commonly entrained at power plants.

<u>Impingement and Entrainment of Aquatic Organisms (Plants with Once-Through Cooling Systems and Cooling Ponds)</u>

In the 1996 GEIS, the NRC considered that for plants with a once-through cooling systems or cooling ponds, the impacts of impingement and entrainment of aquatic organisms were SMALL at many plants but MODERATE to LARGE at a few nuclear plants. Therefore, impingement and entrainment were considered Category 2 issues. For plants that operate in a hybrid mode, impingement and entrainment would be SMALL at most nuclear plants, but could be MODERATE or LARGE at a few plants, and were also considered Category 2 issues.

Impingement is more of a concern at nuclear plants that have once-through cooling because these plants require a larger amount of water than plants that operate under closed-cycle (NRC 1996). Impingement monitoring at the Palisades nuclear power plant in Michigan demonstrated this difference. In 1972, when the plant used once-through cooling, 654,000 fish were impinged yearly at a water withdrawal rate of 400,000 gpm. In 1976, cooling towers were added to the plant, and it began operating as a closed-cycle plant. Intake withdrawal rate was reduced to

78,000 gpm, and impingement dropped to 7,200 fish per year (Consumers Energy Company and Nuclear Management Company 2001). McLean et al. (2002) reported that the magnitude of impingement at Maryland power plants with similar intake designs within Chesapeake Bay differed greatly according to the location of the intake.

Impingement at the Quad Cities plant in Illinois is often an order of magnitude higher from February through April than during summer and fall, even though the cooling water intake flow is only half that of the rest of the year (Bodensteiner and Lewis 1992). Impingement at Quad Cities was primarily composed of young-of-year and juveniles; in the case of gizzard shad (*Dorosoma cepedianum*) and freshwater drum (*Aplodinotus grunniens*), fish of these ages cannot tolerate near-freezing to freezing temperatures during winter and early spring. Other species, such as the bluegill (*Lepomis macrochirus*), channel catfish (*Ictalurus punctatus*), and white bass (*Morone chrysops*), are also prominent in winter impingement collections (Bodensteiner and Lewis 1992, 1994; LaJeone and Monzingo 2000). Although the number of fish impinged at Quad Cities was relatively high (e.g., nearly 3 million in 1989), most (up to 90 percent) of the fishes that entered the intake forebay were dead or moribund. Therefore, even if these fish were not impinged, they would have still been lost from the fishery (LaJeone and Monzingo 2000). Similar results have been noted for impingement of threadfin shad (*Dorosoma petenense*) at the McGuire plant in North Carolina (NRC 2002c) and gizzard shad at the Summer plant in South Carolina (NRC 2004b).

For the Pilgrim plant in Massachusetts, the NRC concluded that impingement during continued operation of the plant would have a MODERATE impact on the Jones River population of the rainbow smelt (*Osmerus mordax*) on the basis of an observed decline of that population, uncertainty about the stock's status, impingement rates, and low impingement survivability. Impingement had a SMALL to MODERATE impact on all other species (NRC 2007c).

For the Wolf Creek plant in Kansas, the NRC concluded that impingement during continued operation of the plant could have SMALL to MODERATE impacts at the makeup water screen house during periods when river water levels were low, because fish would have less available habitat to use as a refuge and would likely be exposed to greater pumping frequency and volume removals from the Neosho River. During most of the license renewal term, the impacts of impingement would be SMALL (NRC 2008a).

Various methods that have been used to reduce impingement include returning impinged fish to the water source, bypassing fish at the intake screens, and preventing the approach of fish to the intake area (Lieberman and Muessio 1978). Various deflection methods that have been used at power plants to reduce impingement include physical barriers, visual stimuli (e.g., air-bubble screens and static or strobe lights), water velocity and pressure changes, electrical shocks, and sound (Maes et al. 2004). These methods have variable effectiveness. For example, sound has been most effective at plants that primarily impinge clupeids

(Maes et al. 2004; Ross et al. 1993, 1996; NRC 2005a,b). Stocking, restoring habitat, and installing cooling towers are also mitigation options.

At the Surry plant in Virginia, about 94 percent of all fish impinged were returned alive to the river through the fish return system. Only five species had less than 80 percent survival. These were the spot (*Leiostomus xanthurus*), Atlantic menhaden (*Brevvortia tyrannus*), blueback herring (*Alosa aestivalis*), threadfin shad, and bay anchovy (*Anchoa mitchilli*) (NRC 2002d). These species generally are susceptible to physical injuries while impinged (e.g., because of their delicate scales). A mitigation program at St. Lucie involves Florida Power and Light Company periodically trapping fish from the intake canal, tagging them, and releasing them in the ocean. The goal is to tag and release 1000 fish per year (NRC 2003a). At the Calvert Cliffs plant in Maryland, about 5.25 million blue crabs (*Callinectes sapidus*) were impinged between 1975 and 1982, but impingement survival was 99 percent (NRC 1999b).

Physical stresses experienced by organisms during impingement are affected by screen wash frequency, screen rotation speed, and screen modifications intended to reduce stress associated with fish separation and handling. Low pressure spray is often used to return organisms to a water body, whereas high pressure spray is used for debris removal. When screens are infrequently washed, impinged organisms may become moribund from repeated attempts to free themselves and may suffocate against the screen (Jinks 2005). Generally, species with heavier skeletal structures, thick scales or bony scutes, thick protective slimes, or hard exoskeletons are most likely to resist physical injury and desiccation during impingement (Jinks 2005).

Although fish return systems can decrease impingement mortality, some stressed and injured fish returned to the water body may take a number of days to die. Even those with minor damage may develop a bacterial or fungal infection that eventually leads to mortality. Also, returned fish may be exhausted, disoriented, and damaged, which makes them more susceptible to predation (Henderson et al. 2003). Replacing conventional intake screens with Ristroph screens is unlikely to result in a significant reduction in impingement mortality at localities where clupeid and sciaenid species predominate (Henderson et al. 2003).

While planktonic organisms are generally not uniformly distributed throughout a water body, it is often assumed that withdrawal of a certain percentage of the source water would result in entrainment of that percentage of the planktonic organisms that pass by a plant (EPA 2002). At Browns Ferry in Alabama, the portion of the river flow that passed through the plant was found to be higher than the percentage of larval fishes in the river that were entrained (NRC 2005c). Fish species with free-floating early life stages are those most susceptible to entrainment (EPA 2002). For power plants (nuclear and fossil) located in the Great Lakes, the number of fish entrained increased with increasing power capacity (Kelso and Milburn 1979).

Entrained organisms are exposed to heat, mechanical, pressure, and chemical stresses (NRC 1996). Entrained organisms are exposed to a rapid temperature rise that is essentially equivalent to the temperature rise across the condensers during their passage through the plant (Schubel et al. 1977). It has been conservatively concluded that mortality of planktonic organisms is assumed to be 100 percent. For ichthyoplankton, this assumption is based on the extreme delicacy of eggs and the fact that their skeleton, musculature, and integument are soft, thereby providing only a minimal amount of protection for vital organs (EPA 2002). Nevertheless, these killed organisms provide food for consumers and decomposers in the receiving water body (Fox and Moyer 1973). Conversely, bacteria and other microorganisms that are entrained may increase in number as a result of prolonged exposure to increased heat (Fox and Moyer 1973; see Section 3.9.3). At the Quad Cities plant in Illinois, LaJeone and Monzingo (2000) concluded that as long as discharge temperatures do not exceed 100°F (37.8°C), some entrainment survival would occur.

Fish eggs and larvae have a high natural mortality rate; thus, the number of entrained ichthyoplankton that would have survived to become adult fish is much lower than the number of eggs and larvae entrained (EPA 2002). In a laboratory study on the exposure of larval common shrimp (*Crangon crangon*) and lobster (*Homarus gammarus*) and adult copepods (*Acartia tonsa*) to simulated entrainment stresses (i.e., thermal, mechanical, chlorine, and pressure effects, both alone and in combination), it was concluded that most individuals of each species would survive passage through a nuclear power station under normal operating conditions. Since the experiments on these crustaceans demonstrated that each species has different responses to different stressors, the only generalization that could be made is that mortality from the totality of entrainment passage would be 10 to 20 percent (Bamber and Seaby 2004).

Mitigation has been used to minimize entrainment losses. This includes several measures that also minimize impingement impacts (e.g., using closed-cycle cooling and designing intakes to minimize velocities through the intake screens). At the McGuire plant in North Carolina, about 45 percent of the cooling water is obtained from the low-level intake, which pulls water from the hypolimnion at a depth of about 100 ft (30 m), where few planktonic organisms occur. Therefore, entrainment is minimized (NRC 2002c). Skimmer walls inside the intake bays at the Robinson plant in South Carolina similarly reduce entrainment (NRC 2003b). At the Millstone plant, potential mitigation measures that were identified included reducing intake flows during the winter flounder (*Pleuronectes americanus*) spawning season; conducting regular inspections, maintenance, or refueling during the spawning season; importing fish into the areas; installing fine mesh screens on the intakes; or installing cooling towers (NRC 2005c).[b]

Section 316(b) of the CWA requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing impingement and entrainment of aquatic organisms. Section 316(b) is regulated under the NPDES program. Two rulemaking phases initiated by EPA associated with Section 316(b) are relevant to nuclear power plant cooling water intake structures. Phase I (enacted in December 2001) is for new facilities (40 CFR 125.83) with a design intake flow greater than 2 million gpd (7.6 million L/d) and that use at least 25 percent of water withdrawn used for cooling purposes (40 CFR Part 125, Subpart I). Phase II (enacted in July 2004) applies to existing large electric generating facilities with a design intake flow of 50 million gpd (189 million L/d) or more and that use at least 25 percent of the water withdrawn for cooling purposes (40 CFR Part 125, Subpart J). The Phase II Rule was suspended on July 9, 2007, after several of its key provisions were remanded by the U.S. Court of Appeals.

As of late 2012, existing nuclear power plant facilities with a cooling water intake structure that are not currently subject to a national rule require Section 316(b) NPDES permit conditions that reflect best technology available for minimizing adverse environmental impact on a case-by-case, best professional judgment basis (40 CFR 125.90(b) and 401.14). The NRC expects that any site-specific mitigation required under the NPDES permitting process should result in a reduction in the impacts of continued plant operations.

In the 1996 GEIS, the NRC categorized the impacts of license renewal on impingement and entrainment of aquatic organisms to be SMALL, MODERATE, or LARGE at plants with once-through cooling or cooling ponds (i.e., a Category 2 issue). No new information has been identified in the plant-specific SEISs prepared to date or in the literature that would alter those conclusions.

On the basis of these considerations, the NRC concludes that the impingement and entrainment of aquatic organisms over the license renewal term at nuclear plants with once-through cooling or cooling ponds could be SMALL, MODERATE, or LARGE and remains a Category 2 issue. The magnitude of the impact would depend on plant-specific characteristics of the cooling system (including location, intake velocities, screening technologies, and withdrawal rates) and

(b) The NRC cannot impose water quality mitigation requirements on licensees. The Atomic Safety and Licensing Appeal Board, in the “Yellow Creek” case, determined that the EPA has sole jurisdiction over the regulation of water quality with respect to the withdrawal and discharge of waters for nuclear power stations, and it also determined that the NRC is prohibited from placing any restrictions or requirements on the licensees of those facilities with regard to water quality (Tennessee Valley Authority [Yellow Creek Nuclear Plant, Units 1 and 2], ALAB-515, 8 NRC 702, 712-13 [1978]).

characteristics of the aquatic resource (including population distribution, status, management objectives, and life history).

Impingement and Entrainment of Aquatic Organisms (Plants with Cooling Towers)

Removal of any substantial volume of water from a natural body of water by a cooling system will likely also remove or kill some of the aquatic organisms that live there through impingement or entrainment. However, the number of individuals that could be removed from a population before detectable negative effects would occur is often not known. The potential for impingement and entrainment of aquatic organisms is influenced by a variety of factors such as:

- Amount of water withdrawn relative to the size of the cooling water source,
- Location and configuration of intake structures,
- Type of water body from which water is withdrawn and the conditions within that water body,
- Proximity of withdrawal structures to sensitive biological habitats (e.g., spawning and nursery habitats),
- Sensitivity of populations of impinged and entrained organisms to potential losses of individuals, and
- Mitigation measures in place to reduce impingement and entrainment.

Of these factors, the volume of water withdrawn relative to the size of the water source appears to be the best predictor of the number of organisms that would be impinged or entrained within a given aquatic system (Henderson and Seaby 2000). Because the volume of water withdrawn by a power plant is minimized when a closed-cycle cooling system is employed, the impacts to aquatic organisms from impingement and entrainment would be smaller than the impacts from impingement and entrainment that would occur if that plant employed a once-through cooling system instead.

In the 1996 GEIS, the NRC determined that impingement and entrainment of fish and shellfish was a Category 1 issue for plants with cooling towers, because the level of impingement and entrainment of fish and shellfish with this type of cooling system was not found to be a problem at operating plants, and was not expected to be a problem during the license renewal term (NRC 1996). This finding was also based on the lower rates of water withdrawal required for plants with cooling towers when operating in a closed-cycle mode. Withdrawal rates would not be reduced in situations where cooling towers are used in a helper mode to cool discharge temperatures under once-through operating conditions. These types of systems are included under the evaluation of once-through systems above.

In considering the impingement and entrainment effects of closed-cycle cooling systems on aquatic ecology, the NRC evaluated the same issues that were evaluated for plants with once-through cooling systems or cooling ponds. On the basis of reviews of the literature and license renewal SEISs published to date, reduced populations of aquatic biota attributable to occurrences of impingement and entrainment have not been reported for any existing nuclear power plants with cooling towers operated in closed-cycle mode.

On the basis of these considerations, the NRC concludes that the impingement and entrainment of aquatic organisms at plants with cooling towers operating as a closed-cycle cooling system over the license renewal term would be SMALL and remains a Category 1 issue.

Entrainment of Phytoplankton and Zooplankton (All Plants)

In addition to the entrainment of fish and shellfish in early life stages, the entrainment of phytoplankton and zooplankton was evaluated in the 1996 GEIS, and entrainment was categorized as a Category 1 issue for all cooling systems.

As described in the previous sections, water that is withdrawn for power plant cooling carries with it a variety of aquatic organisms. Those organisms that are small enough to pass through the debris screens in the intake pass through the entire cooling system and are exposed to heat, mechanical and pressure stresses, and possibly biocides before being discharged to the receiving water. This process, called entrainment, may affect phytoplankton and zooplankton, as well as planktonic larval stages of benthic organisms such as shellfish (i.e., meroplankton), and fish eggs and larvae (ichthyoplankton), as separately evaluated above. Most nuclear power plants have been required to monitor for entrainment effects during the initial years of operation. Entrainment impacts to phytoplankton and zooplankton are considered to be of SMALL significance if there is no evidence of reductions of populations of phytoplankton or zooplankton.

For example, about 70 percent of the copepod entrained at the Millstone plant in Connecticut suffered mortality, but this loss only represented 0.1 to 0.3 percent of the copepod production of eastern Long Island Sound (Carpenter et al. 1974). At the Calvert Cliffs plant in Maryland, entrainment survival for the five most abundant zooplankton species was 65 to 100 percent (NRC 1999b). Except for one sample (when discharge temperatures at the Cook plant in Michigan exceeded 95°F [35°C] and resulted in a 14 to 22 percent mortality difference in zooplankton), there was no relationship between zooplankton mortality and discharge water temperatures, suggesting that mechanical stress was the major cause of zooplankton entrainment mortality. During the period of the study, chlorination was infrequent because entrained sand provided sufficient scouring action to negate the need for biocides. The sand may have added to the mechanical stress experienced by entrained zooplankton. Zooplankton mortality was significantly greater in the discharge waters than the intake waters, but differences averaged less than 3 percent. Such small losses due to entrainment cannot be detected in the lake. It was concluded that fish predation rather than entrainment was the major source of zooplankton mortality in inshore waters during most of the year (Evans et al. 1986).

Entrainment of phytoplankton and zooplankton is expected to have a SMALL impact on populations of these organisms in source water bodies for all plants. No change in operation of the cooling system is expected during the license renewal term, so no change in effects on entrainment of phytoplankton and zooplankton is anticipated. Effects on entrainment of phytoplankton and zooplankton could be reduced by changing to a closed cycle cooling system or by reducing the plant's generation rate. However, because the effects on entrainment of phytoplankton and zooplankton are considered to be impacts of SMALL significance, this issue continues to be Category 1.

Effects of Thermal Discharges on Aquatic Organisms

During the license renewal term, thermal discharges from the cooling system would continue to affect aquatic resources. The potential impacts of thermal discharges are different for once-through and closed-cycle cooling systems as discussed below.

<u>Thermal Impacts on Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds)</u>

In the 1996 GEIS, the NRC found that for plants with a once-through cooling system or cooling ponds, the level of impact for thermal discharge on aquatic biota (primarily due to heat shock) was SMALL at many plants and MODERATE or LARGE at some nuclear plants. Because characteristics of both the thermal discharges and the affected aquatic resources are specific to each site, NRC classified heat shock as a Category 2 issue that required a site-specific assessment for license renewal. The NRC (1996) found the potential for thermal discharge impacts to be greatest at plants with once-through cooling systems (NRC 1996), primarily because of the higher discharge temperatures and larger thermal plume area compared to plants with cooling towers.

In the revised GEIS, the NRC assessed potential impacts of thermal discharges during the renewal term (the remaining years of the original license plus 20 additional years) by reviewing published applicant’s Environmental Reports, NRC’s license renewal SEISs, and the relevant scientific literature. For most nuclear plants involved in license renewal, NRC projected that the impact levels of thermal discharges during the license renewal term would be SMALL. The NRC found impact levels at the Crystal River plant, for example, to be SMALL to MODERATE. According to York et al. (2005), thermal discharges from the Diablo Canyon and San Onofre plants, both located on the California coast and employing once-through cooling systems, have had significant impacts on aquatic habitats. The NRC is reviewing the Diablo Canyon plant's application for license renewal, and the San Onofre plant has not submitted an application at the time of this review, so NRC has neither completely assessed impacts at these two plants nor assigned impact levels. Other site-specific considerations for thermal discharges during the license renewal term for plants with once-through cooling systems can occur for plants located in areas where restoration efforts are under way to increase natural resource populations or reestablish migratory fish species or where thermal discharge plumes could encompass otherwise high-quality habitats. Site-specific design features, such as locating the discharge structures in areas where warmer water would be rapidly diluted, may mitigate adverse thermal effects (Beitinger et al. 2000). Hall et al.'s (1978) finding that the potential for thermal discharge impacts is greatest in shallow, enclosed, and poorly mixed water bodies illustrates the site-specific influence of receiving water body characteristics on environmental impact.

One form of thermal impact is heat shock, which NRC defines as occurring when the water temperature meets or exceeds the thermal tolerance of a species for some duration of exposure (NRC 2007d). In most situations, fish are capable of moving out of an area that exceeds their thermal tolerance limits, although many aquatic resource species lack such mobility. Heat shock is typically observable only for fish species, particularly those that float when dead, so the following discussion emphasizes fish.

Some nuclear plants have reported occasional fish kills from heat shock. At the Pilgrim plant in Massachusetts, only two fish mortality incidents have been attributed to heat shock. In 1975, about 3,000 Atlantic menhaden (*Brevoortia tyrannus*) were killed, and in 1978, about 2,300 clupeids (schooling fish such as menhaden sardines, and shad (*Alosa* spp.)) were killed (NRC 2007d). At the McGuire plant in North Carolina, five dead striped bass (*Morone saxatilis*) were found in and near the discharge, although their deaths may or may not have been related to heat shock (NRC 2002c). Over 94,000 dead fish, mostly bluefill (*Lepomis macrochirus*), were killed when cooling lake temperatures near the La Salle County Station in Illinois exceeded upper lethal temperatures for most species (Exelon 2001c). Similar heat shock kills happened at the Braidwood Nuclear Station's cooling lake when about 1,000 fish, mostly gizzard shad (*Dorosoma cepedianum*), died (NRC 2005e); on July 22, 2001, when about 700 unidentified fish were killed (Exelon 2001b); and on June 28, 2005, when about 10,000 unidentified fish were killed (Exelon 2005).

Another form of thermal impact involves the sublethal effects from thermal discharges (e.g., stunning or disorientation) that could alter predator-prey interactions by increasing the susceptibility of affected individuals to predation. Schubel et al. (1977) concluded that the exposure of fish larvae (e.g., blueback herring (*Alosa aestvalis*), American shad (*A. sapidissima*), striped bass) to an excess of 59°F (15°C) would significantly increase their vulnerability to predation. However, the 1996 GEIS did not report population- or community-level effects from power plant influences on predator-prey relationships in the field, and such effects are difficult to prove from field studies. Organisms overwintering within thermal plumes can also experience chronic malnutrition (Hall et al. 1978). Thermal discharges can also increase the susceptibility of fishes to diseases and parasites as a result of a combination of the increased density of fish within the thermal plume (potentially leading to increased exposure to infectious diseases or other stresses), the fish being more prone to infection in warmer water, and the ability of diseases and parasites to develop faster at higher temperatures. Examples of other temperature-related impacts on aquatic resources could include the loss of smolt characteristics in salmon (McCormick et al. 1999) and premature spawning (Hall et al. 1978).

A number of mitigative measures can reduce thermal discharge effects. These include lowering the effluent temperatures before discharges reach the receiving water body (e.g., the cooling pond at the Dresden plant in Illinois or the cooling canal system at the Turkey Point plant in Florida) or enhancing rapid mixing and heat dissipation (e.g., high-velocity jet diffusers at FitzPatrick in New York) (NRC 1996). At the Surry plant in Virginia, the thermal discharge lies about 6 mi (9.7 km) upstream of the intake structure to protect downstream oyster beds from potential thermal discharge impacts (NRC 2002d). After several fish kills at the Summer plant in the 1980s, South Caroline Electric & Gas Co. removed a hump in the discharge canal, limited reservoir drawdowns, and dredged the discharge canal to reduce the likelihood of future fish kills (NRC 2004b).

The NRC (1996) concluded that the impact levels of heat shock on aquatic biota during the license renewal term could be SMALL, MODERATE, or LARGE at plants with once-through cooling or cooling ponds (i.e., a Category 2 issue). The present review identified no new information that would alter those conclusions for effects of thermal discharges in the plant-specific SEISs prepared to date or in other literature. Based on these considerations, the NRC concludes that the issue of thermal discharges on aquatic organisms at nuclear plants with once-through cooling systems or cooling ponds over the license renewal term could have SMALL, MODERATE, or LARGE impact levels and is a Category 2 issue. The impact level at any plant depends on the characteristics of its cooling system (including location and type of discharge structure, discharge velocity and volume, and three-dimensional characteristics of the thermal plume) and characteristics of the affected aquatic resources (including the species present and their physiology, habitat, population distribution, status, management objectives, and life history).

<u>Thermal Impacts on Aquatic Organisms (Plants with Cooling Towers)</u>

In the 1996 GEIS, the NRC determined that for plants with cooling towers, the effects of thermal discharges with respect to heat shock (i.e., the potential for heated effluents to directly kill aquatic organisms) was a Category 1 issue. This determination was made because thermal effects associated with this type of cooling system were not found to be a problem at operating plants and are not expected to be a problem during the license renewal term (NRC 1996). This finding was based, in part, on the presence of smaller thermal plumes at plants with closed-cycle cooling towers than would occur if a once-through cooling system was used at those plants. Other sublethal effects of thermal discharges are discussed and evaluated separately below (see Infrequency Reported Thermal Impacts (All Plants)).

In the 1996 GEIS, the NRC considered the impacts of thermal discharges on aquatic organisms during the license renewal term to be SMALL at nuclear plants with cooling towers (i.e., a Category 1 issue). No new information has been identified in the plant-specific SEISs prepared to date or in the literature that would alter those conclusions. On the basis of these considerations, the NRC concludes that the direct impact of thermal discharges on aquatic organisms at nuclear plants with cooling towers over the license renewal term would be SMALL and remains a Category 1 issue.

Infrequently Reported Thermal Impacts (All Plants)

In addition to the effects of heat shock as described above for plants with once-through cooling systems or cooling ponds and those using cooling towers, other potential effects common to the operation of plant cooling systems include cold shock, the creation of thermal plume migration barriers, changes in the distribution of aquatic organisms, accelerated development of aquatic insect maturation, and stimulation of the growth of aquatic nuisance species. The 1996 GEIS addressed these uncommon impacts individually; this revised GEIS consolidates them. The components of the consolidated issue are further described below.

Cold shock can occur when organisms acclimated to the elevated temperatures of a thermal plume are abruptly exposed to temperature decreases when the artificial source of heating stops. Such events are most likely to occur during winter. Cold shock events have only rarely occurred at nuclear plants (e.g., Haddam Neck [no longer operating], Prairie Island, Monticello, and Oyster Creek). Fish mortalities usually involved only a few fish and did not result in population-level effects (NRC 1996). Gradual shutdown of plant operations generally precludes cold shock events.

The potential exists for thermal plumes to create a barrier to migrating fishes if the mixing zone covers an extensive cross-sectional area of a river and exceeds the fish avoidance temperature (NRC 1996). For example, concerns were expressed that thermal discharge from the Vermont Yankee plant could affect both spawning and outmigration of American shad (*Alosa sapidissima*) and Atlantic salmon (*Salmo salar*) and potentially cause a reduction in Atlantic salmon smoltification, particularly since a hydroelectric facility was located immediately downstream of the plant and because the fish passage facility and thermal discharge were located on the same side of the river (NRC 2007a). In the 316(b) demonstration to support increased discharge temperature limits at the Vermont Yankee plant, it was determined that the smolts would not be delayed because the thermal plume covered only a small cross section of the Connecticut River. To date, significant impacts on migratory fishes have not been reported for nuclear power plants.

Impacts of thermal discharges on the geographic distribution of aquatic organisms are considered to be of SMALL significance if populations in the overall region are not reduced. Based on review of literature, operational monitoring reports, consultations with utilities and regulatory agencies, and license renewal SEISs published to date, thermal discharges have not been shown to constrain the regional geographic distribution of aquatic organisms at any existing nuclear power plant. This is because heat is usually dissipated rapidly from power plant discharge plumes, and heated plumes are often small relative to the size of the receiving water body.

Heated effluents could accelerate the development of immature stages of aquatic insects in freshwater systems, resulting in premature emergence. If adults emerge before the normal seasonal cycle, they may be unable to feed or reproduce. Premature emergence has been observed in laboratory investigations (e.g., Nebeker 1971) but not in field investigations (e.g., Langford 1975). Heated effluents could also stimulate population growth of macroinvertebrates. Thermal discharges from the Oconee plant in South Carolina stimulated the population growth of oligochaetes (aquatic worms) in the immediate vicinity of the power plant (less than 5 percent of the total cooling reservoir surface). However, the local changes in oligochaete populations could not be linked to the direct increases in water temperatures, but they may have been directly or indirectly affected by increases in zooplankton, vegetation, and current velocities in the area of the discharge (Nichols 1981).

An aquatic nuisance species is “a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters” (Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990). A wide variety of nuisance or non-native species may become established or proliferate as a result of power plant operations, including fouling organisms such as the Asiatic clam and the recently introduced zebra mussel. Aspects of the operation of the power plants (e.g., warm temperatures or high flow rates that bring food to filter-feeding organisms) may be conducive to the growth and development of these organisms. *Asiatic clams* and zebra mussels may become so abundant as to cause operational difficulties for the power plant and may out-compete native clams and mussels in thermally enriched waters. A population of tropical, nonnative blue tilapia (*Oreochromis aureus*) became established in the Susquehanna River in Pennsylvania by congregating in thermal effluents during the winter. Exposure to rapid temperature decreases (cold shock) killed these fish and eradicated the population from the vicinity of the plant.

Langford (1983) reports a number of instances in which wood-boring crustaceans and mollusks, notably “shipworms,” have caused concern in British waters. Although increased abundance of shipworms in the area influenced by heated power plant effluents caused substantial damage to wooden structures, replacement of old wood with concrete or metal structures eliminated the problem. Langford concluded that increased temperatures could enhance the activity and reproduction of wood-boring organisms in enclosed or limited areas but that elevated temperature patterns were not sufficiently stable to cause widespread effects.

Thermal discharges can allow nuisance species, such as the Asiatic clam (*Corbicula fluminea*) and zebra mussel (*Dreissena polymorpha*), to become established or proliferate (NRC 1996). At the North Anna plant in Virginia, the higher water discharges related to plant operation were found to increase the growing season of the water hyacinth (*Hydrilla verticillata*). Nuisance levels of this plant resulted. The water hyacinth was brought under control by stocking triploid (sterile) herbivorous grass carp (*Ctenopharyngodon idella*) (NRC 2002e).

The influence of the operation of Oyster Creek Nuclear Generating Station on abundance and distribution of a nonnative, tropical-subtropical, wood-boring shipworm (*Teredo bartschi*) has been extensively studied (see summary in Richards et al. 1984). Although numerous studies have varied somewhat in their conclusions, there is agreement that heated effluents from the plant increased the distribution and abundance of shipworms (Kennish et al. 1984). This species has not been found in Oyster Creek or Barnegat Bay since 1982, perhaps because of low water temperatures in Oyster Creek during a station outage in the winter of 1981–82 and the pathological effects of a parasite (GPU Nuclear Corporation response to a Nuclear Management and Resources Council [NUMARC] survey [NUMARC 1990]). In addition, the removal of substantial amounts of driftwood and the replacement of untreated structural wood is thought to have contributed to reducing the populations of wood-boring organisms in Oyster Creek. No other concerns about nuisance organisms were cited by the regulatory or resource agencies contacted for this GEIS revision (Appendix F). Measures taken by licensees to control nuisance species (e.g., increased chlorination or use of molluscicides) may result in impacts on other species. This impact is also controlled by NPDES permitting procedures.

The effects of stimulating the growth of nuisance organisms are considered to be of SMALL significance to aquatic resources if these organisms are restricted to the condenser cooling system (e.g., Asiatic clam; zebra mussel) or do not proliferate beyond the immediate vicinity of the plant. Mitigation measures were effective at the one plant that experienced problems with nuisance organisms (e.g., shipworms). Effects on nuisance organisms could be reduced by changing to a closed-cycle cooling system or by reducing the plant’s generation rate, but, based on the review conducted by NRC for this GEIS revision, NRC categorizes the impact level as SMALL and would expect it to be SMALL for all plants.

The NRC's review revealed only small levels of impact in the aquatic resources due to the infrequently reported thermal impacts and expects the same at all plants. As a result, NRC classifies this combined issue as Category 1.

Effects of Cooling Water Discharge on Dissolved Oxygen, Gas Supersaturation, and Eutrophication

The potential effects on aquatic biota from low dissolved oxygen levels, gas supersaturation (gas bubble disease), and eutrophication in the cooling water discharge of nuclear power plants were identified as Category 1 issues in the 1996 GEIS. These three issues are combined and discussed together here.

The availability of oxygen is a requirement for the metabolism of aerobic organisms. It also influences inorganic chemical reactions. For aquatic organisms with gills, the concentration of dissolved oxygen in the water is one of the most important parameters to consider for evaluating water quality. In general, dissolved oxygen concentrations of less than 3 ppm in warmwater habitats or less than 5 ppm in coldwater habitats can adversely affect fish (Morrow and Fischenich 2000). Oxygen dissolves into water via diffusion from the surrounding air, by aeration (i.e., mixing with atmospheric air due to turbulent movement of the water), and as a product of photosynthesis. The level of dissolved oxygen in water is highly dependent on temperature, and the amount of oxygen that can dissolve in a given volume of water (i.e., the saturation point) is inversely proportional to the temperature of the water. Thus, when other chemical and physical conditions are equal, the warmer the water is, the less dissolved oxygen it can hold. An increase in water temperature also affects the amount of oxygen that aquatic organisms need by increasing the chemical reaction rates and metabolic rates. The rates of many chemical reactions in water approximately double for every 18°F (10°C) increase in temperature. Thus, the addition of a heat load to an aquatic ecosystem via the discharge of cooling water has the potential to stress aquatic biota by simultaneously increasing metabolic rates and the need for oxygen and by reducing dissolved oxygen concentrations to suboptimal levels.

The potential for effects on biota from a reduction in the dissolved oxygen concentration is greater in ecosystems where dissolved oxygen levels are already approaching suboptimal levels as a result of other factors that affect the environment. Thus, organisms in ecosystems where (1) the biological demand for dissolved oxygen is elevated as a result of increased levels of detritus or nutrients (e.g., eutrophication from runoff containing fertilizers or manure or from the release of dead, entrained organisms in the discharge of once-through cooling systems) or (2) low flow levels and high ambient temperatures already exist (e.g., as a result of drought conditions or hot weather) may be more susceptible to negative effects if dissolved oxygen levels are reduced further. For this reason, the EPA and States often regulate dissolved oxygen to ensure that minimum levels will be maintained. The following discussion focuses on dissolved oxygen because it directly affects aquatic resources rather than focusing on the contributing causes of low dissolved oxygen levels associated with cooling water system operation (e.g., eutrophication due to increased temperature, lower dissolved oxygen capacity with increased temperature, higher biological oxygen demand (BOD), and chemical oxygen demand (COD) with increased temperature, etc.).

After cooling water is discharged, additional oxygen dissolves in the water as a result of diffusion and the introduction of oxygen released by aquatic plants and algae as a by-product of photosynthesis (during daylight hours only). The saturation point for the water increases as it cools, and aeration due to turbulent movement can further increase the rate of oxygenation. For these reasons, effects on aquatic biota due to low dissolved oxygen levels are not expected to extend beyond the thermal mixing zone. Thus, even in cases where dissolved oxygen levels in the immediate vicinity of the discharge structures of power plants may be too low to support some aquatic biota, the amount of aquatic habitat affected is typically small relative to that available in the receiving water body as a whole. Discharge systems are typically designed to minimize the affected area by promoting mixing of introduced warmer water with ambient water from the receiving system, by increasing turbulence near the discharge point, or by introducing air into the water.

The impacts of low dissolved oxygen concentrations in the discharge are considered to be of SMALL significance if populations of aquatic organisms in the vicinity of the plant are not reduced. On the basis of reviews of literature and operational monitoring reports, dissolved oxygen concentrations have been adequate for maintaining aquatic ecosystems in the water bodies that receive cooling water from currently operating nuclear power plants. Operational mitigation measures (increasing the oxygenation of water released from an upstream dam) have been effective at the one plant (Sequoyah plant in Tennessee) for which periodic low dissolved oxygen levels in the receiving water (Chickamauga Reservoir) were identified as potentially affecting downstream mussel beds and sauger (*Sander canadensis*) reproduction during the initial license term.

In addition to the effects of cooling systems on dissolved oxygen described above, rapid heating of water in the condenser cooling system also decreases the solubility and saturation point for other dissolved gases. Thus, as the water passing through the cooling system is heated, the water becomes supersaturated with gases. Although the levels of dissolved gases will equilibrate to normal values as the water cools and mixes with ambient waters, tissues of aquatic organisms that remain in the supersaturated effluent for extended periods can become equilibrated to the increased partial pressures of gases within the effluent. If these organisms are subsequently exposed to water with lower partial pressures (which occurs when the water cools or when the organisms move to water in other locations or at other depths), dissolved gas (especially nitrogen) within the tissues may come out of solution and form embolisms (bubbles) within the affected tissues, most noticeably the eyes and fins. The resulting condition is known as gas bubble disease. Swelling and hemorrhages in tissues can cause behavioral abnormalities or death, depending on the number of bubbles that form and the tissues that are affected (Noga 2000). Fish mortalities generally occur at gas supersaturation levels above 110 to 115 percent (EPA 1986). Aquatic insects and crustaceans appear to be more tolerant of supersaturated water than fish (Nebeker et al. 1981).

The ability to detect and avoid supersaturated waters varies among species. A fish can avoid supersaturated waters by either not entering the affected area or by diving to avoid the onset of supersaturated conditions near the surface. Some species, however, may not avoid supersaturated waters until symptoms of gas bubble disease occur; at that point, some fish may already have been lethally exposed. Other species may be attracted to supersaturated waters due to stimuli such as warmwater discharges (Gray et al. 1983).

Gas supersaturation and gas bubble disease have resulted in the death of fish in the discharge of some steam-electric power plants, as has been reported in the past from the Pilgrim plant in Massachusetts (NRC 1996, 2007c). Gas supersaturation and gas bubble disease are also commonly associated with hydroelectric dams, typically resulting when water that is mixed with air while traveling over spillways is subsequently pushed to depth within stilling basins (Parametrix, Inc. 1975). The death of organisms due to gas supersaturation in heated effluents from power plants appears to be most likely at plants that have discharge canals where fish may reside for extended periods of time (i.e., long enough to equilibrate with supersaturated effluents). Gas solubility tends to increase with decreases in water temperatures; therefore, gas bubble disease at steam-electric stations would be most likely to occur during winter months (McInerny 1990). As reported in the 1996 GEIS, observed incidences of gas bubble disease at the Waukegan Generating Station (a coal-fired plant on Lake Michigan), Marshall Steam Station (a coal-fired plant on Lake Norman), and the Pilgrim plant involved fish residing in discharge canals. At the Pilgrim plant, the loss of approximately 43,000 Atlantic menhaden in 1973 was attributed to gas bubble disease (McInerny 1990), and other species of fish may also have been affected (Fairbanks and Lawton 1977). Promoting the rapid mixing of effluents with receiving waters (e.g., with jet diffuser systems) appears to effectively prevent such mortalities by inhibiting residence of organisms in the thermal plume (Lee and Martin 1975) and by limiting the extent of the area where supersaturated conditions may occur. Restricting entry of fish into discharge canals may also be effective at controlling mortality. A fish barrier net was installed in the discharge canal at the Pilgrim plant after the mortality events observed during the 1970s, although subsequent implementation of engineering controls have mitigated conditions so that the use of the net has not been required since then.

Impacts from gas supersaturation are considered to be of SMALL significance if populations of aquatic organisms in the vicinity of the plant are not reduced. On the basis of reviews of the available scientific literature, plant-specific ERs, and the SEISs that have been completed to date, deaths of aquatic organisms attributable to gas supersaturation have not been a concern at most existing nuclear power plants. Operational and structural mitigation measures have been effective at controlling effects on fish at the Pilgrim plant, where fish kills attributable to gas supersaturation occurred during the initial license period. In no case has a substantial effect on populations of aquatic organisms been observed. Use of engineering controls (e.g., use of jet diffusers for cooling water discharge systems) that prevent the occurrence of mortality due to gas bubble disease at individual power plants also reduces the likelihood that discharges from cooling systems would contribute to cumulative effects.

Unless the operation of the cooling system or the ambient conditions that affect levels of dissolved oxygen or gas supersaturation in the receiving waters were to change substantially, it is anticipated that there would be no change in effects of low dissolved oxygen concentrations or gas supersaturation on aquatic biota during the license renewal term. Overall, effects of low dissolved oxygen concentrations and gas supersaturation attributable to cooling water discharges are considered to be of SMALL significance for all plants.

For some plants, the potential for effects of low dissolved oxygen concentrations or gas supersaturation on aquatic resources could be further reduced by changing from a once-through cooling system to a closed-cycle cooling system or by reducing the plant's generation rate. However, because the continued effects of operations on dissolved oxygen concentrations and gas supersaturation are considered to be of SMALL overall significance to populations of aquatic resources and because implementation of these changes would be costly, it is believed that such changes are not warranted on the basis of controlling levels of dissolved gases. Impacts of license renewal on dissolved oxygen levels and on the incidence of gas bubble disease were considered to be SMALL for all nuclear plants and were designated as Category 1 issues in the 1996 GEIS. No new information has been identified in the plant-specific SEISs prepared to date or in the literature that would alter those conclusions.

On the basis of these considerations, the NRC concludes that the impact on aquatic biota from the alteration of dissolved oxygen levels and gas supersaturation associated with continued operations over the license renewal term would be SMALL for all nuclear plants and remains a Category 1 issue.

Effects of Nonradiological Contaminants on Aquatic Organisms

The potential for nonradiological contaminants to accumulate in sediments or aquatic biota was identified as a Category 1 issue in the 1996 GEIS. This was originally raised as an issue of concern at a few power plants that used copper alloy condenser tubes, but this concern has been successfully mitigated by replacing copper alloy tubes with those made from other metals (e.g., titanium). An operating nuclear power plant can contribute other contaminants by concentrating existing constituents from the water body (e.g., in blowdown at closed-cycle plants) or by the addition of chemicals to cooling water during plant operations (e.g., biocides).

Biocides are used in cooling water systems to prevent the buildup of microorganisms that can impede heat transfer across heat exchange surfaces. Biocides are also used to prevent excessive growth of algae or other organisms that attach to structures, which can reduce cooling water flow by blocking pipes, tubing, and other water conveyances. For example, zebra mussels and Asiatic clams within the intakes or cooling systems of power plants can cause partial to total blockage of grates and pipes or cause damage to pipes and facilities, requiring the plants to temporarily suspend operations in order to remove the blockage or repair the damage. To prevent this from happening, plants in areas where these mollusks occur generally use nonoxidizing molluscicides (e.g., quaternary ammonium salts, glutaraldehyde, isothiazoline, triazine, and carbamates). The amount of a biocide that is applied to the cooling waters is controlled so that the concentrations that are discharged from the cooling system are too low to cause adverse effects to native mussels in the receiving water body. Allowable concentrations for biocides in discharged cooling waters are governed by NPDES permit restrictions to reduce the potential for toxic effects on nontargeted organisms (e.g., native mussels and fishes). At the Browns Ferry plant in Alabama, small sponge rubber balls are continuously recirculated through the condenser tubes to keep them clear of Asiatic clams and thus reduce the use of molluscicides (NRC 2005c). Also, various means can be used to minimize the discharged concentrations of biocides in the blowdown, including closing the blowdown valve before biocides are added, discharging blowdown to large sediment or retention ponds, and dechlorination (Veil et al. 1997).

As reported in the 1996 GEIS, heavy or toxic metals (e.g., copper, zinc, and chromium) may be leached from condenser tubing and other heat exchangers and discharged by power plants as small-volume waste streams or corrosion products. Although heavy metals are found in small quantities in natural waters (and many are essential micronutrients), concentrations in the power plant discharge are typically controlled in the NPDES permit because excessive concentrations of heavy metals can be toxic to aquatic organisms. Discharge of metal and other toxic contaminants may also be subject to individual control strategies developed by the States to control toxic pollutants under the CWA. These strategies for point source discharges of toxic pollutants are implemented through the NPDES permit program. Heavy metal concentrations in discharges during normal operations are generally low. However, reactor shutdowns for testing and refueling keep stagnant water in contact with condenser tubes and other metal structures for extended periods and may allow abnormally large amounts of metals to be leached into the water.

The ability of aquatic organisms to bioaccumulate heavy metals, even at low concentrations, has led to concerns about toxicity both to the humans and biota that consume contaminated fish and shellfish. For example, the bioconcentration of copper discharged from the Chalk Point plant (a fossil fuel power plant on Chesapeake Bay) resulted in discoloration (“greening”) effects on eastern oysters (*Crassotrea virginica*) (Roosenburg 1969), and the bioaccumulation of copper released from the Robinson plant in South Carolina resulted in malformations and decreased reproductive capacity among bluegill in the cooling reservoir. Replacement of copper alloy tubes with tubes made from other metals (e.g., titanium) alleviated the elevated copper levels in both of these cases (NRC 1996, 2003b).

Concentrations of heavy metals and other contaminants in the discharges of nuclear power plants are normally quickly diluted or flushed from the area by the large volumes of the receiving water. The discharge of metals and other toxic contaminants may also be subject to controls implemented by State or Federal agencies through the NPDES permit process. Impacts of contaminant discharges are considered to be of SMALL significance if water quality criteria (e.g., NPDES permits) are not violated and if aquatic organisms in the vicinity of the plant are not bioaccumulating the contaminants.

The accumulation of contaminants in sediments and biota was designated as a Category 1 issue in the 1996 GEIS. No new information has been identified in plant-specific SEISs prepared to date or in the reviewed literature that would alter those conclusions. However, this issue has been modified to look at contaminant effects other than accumulation. As long as changes to the cooling system, such as during refurbishment, do not occur during the license renewal term and the discharge requirements of the NPDES permit are met, no impact of contaminants on aquatic biota would be anticipated. On the basis of these considerations, the NRC concludes that the impact of contaminants on aquatic organisms associated with continued operations and refurbishment would be SMALL for all nuclear plants and remains a Category 1 issue.

Exposure of Aquatic Organisms to Radionuclides

The potential impact of radionuclides on aquatic organisms from normal operations of a nuclear power plant during the license renewal term was not identified as an issue in the 1996 GEIS. However, the impact of radionuclides on aquatic organisms has been raised as an issue by the public for several of the plants that have undergone license renewal, and that issue is reviewed here.

Aquatic biota can be exposed externally to ionizing radiation from radionuclides in water, sediment, and other biota, and aquatic biota can be exposed internally via ingested food and water and, in certain situations, absorption through the skin and respiratory organs (Blaylock et al. 1993). No evidence of significant differences in sensitivity to radionuclides between marine and freshwater organisms has been reported (Blaylock et al. 1993). Some radionuclides tend to follow pathways similar to their nutrient analogs and can therefore be transferred rapidly through the food chain. These include (1) radionuclides such as strontium-90, barium-140, radon-226, and calcium-46 that behave like calcium and are therefore accumulated in bony tissues; (2) radionuclides such as iodine-129 and iodine-131 that act like stable iodine and accumulate in thyroid tissue; (3) radionuclides such as potassium-40, cesium-137, and rubidium-86 that follow the general movement of potassium and can be distributed throughout the body; and (4) radionuclides such as tritium, which resembles stable hydrogen, that are distributed throughout the body of an organism (Ahier and Tracy 1995).

Fish, especially developing eggs and young, appear to be the aquatic organisms that are the most sensitive to the effects of ionizing radiation, while phytoplankton and zooplankton are relatively resistant to effects from exposure (NCRP 1991; Blaylock et al. 1993). DOE's guideline for radiation dose rates from environmental sources recommends limiting the radiation dose to aquatic biota to no more than 1 rad/d (0.01 Gy/d). As described in Blaylock et al. (1993), this guideline was derived by reviewing the results of experimental data (NCRP 1991) that indicated there would not be any negative population-level effects on aquatic biota at doses up to 1 rad/d (0.01 Gy/d). That review reported that significant histological effects on the gonads of small tropical fish were detected at a dose of 1 rad/d (0.01 Gy/d), although the majority of controlled studies that examined the potential chronic effects of ionizing radiation on aquatic organisms did not find significant effects unless the dose was much greater than 1 rad/d (0.01 Gy/d) (NCRP 1991). Real et al. (2004) summarized several chronic irradiation studies on fish (mostly from gamma radiation at dose rates of 0.2 to 120 rad/d [0.02 to 1.2 Gy/d]) that reported effects, such as lowered fecundity, delayed spawning, reduced testis mass and sperm production, reduced immune response, reduced larval survival, and increased vertebral anomalies. They concluded that dose rates of less than approximately 10 rad/d (0.1 Gy/d) to any life stage are unlikely to affect survival (Real et al. 2004). Kryshev and Sazykina (1998) reported that ecological effects of ionizing radiation on aquatic biota occur at dose rates between 0.2 and 80,000 rad/d (0.002 and 800 Gy/d)]. For comparison, Brown et al. (2004) used models to estimate doses to aquatic biota from naturally occurring radionuclides as ranging from 0.00024 to 0.11 rad/d (2.4×10^{-6} to 1.1×10^{-3} Gy/d) for European freshwater ecosystems and 0.00024 to 0.06 rad/d (2.4×10^{-6} to 6.0×10^{-4} Gy/d) for European marine waters.

Dose rates for aquatic biota were calculated with the RESRAD-BIOTA dose evaluation model (DOE 2004e) using site-specific radionuclide concentrations in water and sediments reported in the REMP reports for 15 NRC-licensed power plants (Table 4.6-5). (See Section D.5 in Appendix D for a description of the methodology used.) These 15 plants represent plants with a range of radionuclide concentrations in environmental media. The total estimated dose rates for aquatic biota for these plants were all less than 0.2 rad/d (0.002 Gy/d), considerably less than the guideline value of 1 rad/d (0.01 Gy/d). Thus, it is anticipated that normal operations of these facilities would not result in negative effects on aquatic biota. Effects on populations of aquatic biota from such doses would be SMALL. A 25-year study of gamma-ray-emitting radionuclide levels near the Susquehanna plant in Pennsylvania indicated that there have been no known environmental impacts on aquatic resources (Patrick et al. 2007). On the basis of the reviewed literature and the dose rates that have been estimated for aquatic biota from site-specific data, the NRC concludes that the impact of radionuclides on aquatic biota from past operations would be SMALL for all plants, and it would not be expected to change appreciably during the renewal

Table 4.6-5. Estimated Radiation Dose Rates to Aquatic Animals from Radionuclides Measured in Water and Sediments at U.S. Nuclear Power Plants

	Estimated Dose Rates (rad/d)[a]		
Plant	**Water**	**Sediment**	**Total**
Arkansas Nuclear	1.87×10^{-4}	1.98×10^{-6}	1.89×10^{-4}
Browns Ferry	1.43×10^{-2}	2.88×10^{-5}	1.43×10^{-2}
Calvert Cliffs	1.53×10^{-7}	1.09×10^{-10}	1.54×10^{-7}
Columbia	5.01×10^{-2}	2.17×10^{-5}	5.01×10^{-2}
Comanche Peak	5.82×10^{-2}	1.03×10^{-4}	5.83×10^{-2}
D.C. Cook	5.01×10^{-2}	1.46×10^{-4}	5.02×10^{-2}
Hatch	5.02×10^{-2}	1.22×10^{-5}	5.02×10^{-2}
Fort Calhoun	1.06×10^{-1}	5.71×10^{-6}	1.06×10^{-1}
Indian Point	5.01×10^{-2}	2.03×10^{-5}	5.01×10^{-2}
Millstone	5.02×10^{-2}	5.73×10^{-4}	5.08×10^{-2}
Nine Mile Point	5.02×10^{-2}	1.02×10^{-5}	5.02×10^{-2}
Palisades	1.34×10^{-7}	3.65×10^{-6}	3.78×10^{-6}
Point Beach	2.67×10^{-3}	2.73×10^{-4}	2.95×10^{-3}
San Onofre	1.12×10^{-2}	3.00×10^{-4}	1.15×10^{-2}
Vermont Yankee	5.02×10^{-2}	1.11×10^{-3}	5.13×10^{-2}

(a) Dose rates were estimated with RESRAD-BIOTA (DOE 2004e) by using site-specific radionuclide concentrations in water and sediments obtained from REMP reports.

period. Therefore, the impact of radionuclides on aquatic biota that would result from continued operations is considered a Category 1 issue.

Effects of Dredging on Aquatic Organisms

Dredging is an activity that is performed at some power plants to remove accumulated sediments from intake and discharge areas (or, more rarely, to maintain barge slips) and may have localized impacts on aquatic biota. The impacts of dredging were not evaluated in the 1996 GEIS.

Sediment (especially sand and silt) that enters water bodies through the process of erosion can accumulate and gradually fill in some areas. Because of this, maintenance dredging may be required at some power plants to keep cooling water intakes and discharges clear of sediment

(Allen et al. 2004; NRC 2007b,c). Dredging may also occur as part of power plant operation to maintain appropriate water circulation in water bodies that provide cooling water (e.g., at the Millstone plant; NRC 2005c) or to maintain access for barges (e.g., at the Calvert Cliffs plant in Maryland; NRC 1999b). Dredging can be accomplished in a number of ways (e.g., using various types of mechanical or hydraulic dredges), but it generally entails excavating a layer of sediment from the affected areas and transporting it to onshore or offshore areas for disposal.

Dredging can affect aquatic biota in a variety of ways. Except for some deep-burrowing animals or motile animals, such as larger crustaceans and fish, that may survive dredging through avoidance, it is assumed that organisms living on or in the affected sediments will be killed. Sediments suspended in the water column during dredging activities may settle onto and bury adjacent habitats, clog the feeding structures of filter-feeding organisms, or reduce light penetration. The potential for impacts on aquatic organisms as a result of direct effects of suspended sediment depends on the types of organisms present in the affected area, the amount and particle sizes of the sediment, and the duration of dredging activities (Nichols et al. 1990; Wilber and Clarke 2001).

The recovery of benthic communities in habitats disturbed by dredging depends, in part, on the characteristics of the remaining sediments (Diaz 1994; Haynes and Makarewicz 1982), the sources and types of organisms available to recolonize from surrounding areas, and the size of the disturbed area (Whitlatch et al. 1998). In soft-sediment environments, such as those that are most likely to require dredging in the vicinity of power plant intakes, recovery of animal communities generally occurs relatively quickly (sometimes within weeks) especially if the dredged areas are relatively small (e.g., Diaz 1994). In some cases, however, recovery of benthic communities may take several years (e.g., Kaplan et al. 1975; Guerra-García et al. 2003). Recovery of benthic communities following dredging also tends to be faster in areas exposed to periodic disturbances, such as tidally influenced habitats (Diaz 1994).

Sediments in and around cities and industrial areas are often contaminated with a variety of pollutants. These pollutants are introduced to waterways from point sources such as combined sewer overflows, municipal and industrial discharges and spills, or may be introduced from nonpoint sources such as surface runoff and atmospheric deposition. Contaminants that have accumulated in buried layers of sediment are often less readily bioavailable or less chemically active (EPA 2004). Depending on the concentrations of specific contaminants in accumulated sediments, there could be increased bioavailability and increased toxicity of those contaminants if they are resuspended in the water column due to dredging activities (Petersen et al. 1997; Su et al. 2002; EPA 2004). On the basis of a review of the information in the ERs and SEISs that have been prepared for previous renewal applications, the levels of chemical and radionuclide contamination of sediments in the areas near power plant intakes and discharges that would need to be dredged are likely to be relatively low. For example, as reported in the

SEIS for license renewal for the Pilgrim Nuclear Power Station in Massachusetts, the toxicity of sediments to marine organisms, which was evaluated prior to dredging the intake channel, was found to be low (NRC 2007c).

In general, maintenance dredging for nuclear power plant operations would occur infrequently, would be of relatively short duration, and would affect relatively small areas. For example, at the Peach Bottom Atomic Power Station in Pennsylvania, it is estimated that dredging of the intake basins is performed approximately once every 20 years and a total area of approximately 6 ac (2.4 ha) would need to be dredged (NRC 2003a). Portions of either the intake or the discharge canals at the Oyster Creek Nuclear Generating Station in New Jersey have been dredged approximately every 10 years (NRC 2007b), and the intake area for the Monticello Nuclear Generating Plant in Minnesota requires dredging every 6 to 8 years (NRC 2006c). It is anticipated that maintenance dredging would be primarily undertaken in areas containing soft sediments that would be recolonized fairly rapidly by benthic organisms in surrounding areas. In addition, permits from the USACE, State environmental agencies, or other applicable regulatory authorities would be required prior to initiating dredging. Site-specific evaluation of potential environmental impacts, including potential impacts on listed species of aquatic organisms, would be considered as part of the permitting process, and appropriate mitigation measures, if needed, could be identified and implemented.

Available scientific literature, plant-specific ERs, and the SEISs that were reviewed indicate that the effects of these dredging activities on populations or communities of aquatic organisms would likely be SMALL at all plants where they occur. On the basis of these considerations, the NRC concludes that the impact of dredging on aquatic resources would be SMALL for all nuclear plants and is considered a Category 1 issue.

Water Use Conflicts with Aquatic Resources (Plants with Cooling Ponds or Cooling Towers Using Makeup Water from a River)

In the 1996 GEIS, water use conflicts was listed as a site-specific, surface water quantity issue that included within it ecological impacts on aquatic and riparian communities. The NRC separated out the ecological impacts in this revised GEIS because the effects of water use conflicts on aquatic resources in stream communities could occur under many scenarios.

Increased temperatures and/or decreased rainfall would result in lower river flows, increased cooling pond evaporation, and lowered water levels in the Great Lakes or reservoirs. Regardless of overall climate change, droughts could result in problems with water supplies and allocations. Because future agricultural, municipal, and industrial users would continue to share their demands for surface water with power plants, conflicts might arise if the availability of this resource decreased.

Water use conflicts with aquatic resources could occur when water to support these resources is diminished either because of decreased water availability due to droughts; increased demand for agricultural, municipal, or industrial usage; or due to a combination of such factors. Water use conflicts with biological resources in stream communities is a concern due to the duration of license renewal and potentially increasing demands on surface water.

For example, Wolf Creek uses Coffee County Lake for cooling (NRC 2008a). Makeup water for the lake is withdrawn from the Neosho River downstream of John Redmond Reservoir. The Neosho River is a river with low water flow during drought conditions. The aquatic communities in the Neosho River downstream include an endangered fish species, the Neosho madtom (*Noturus placidus*), that may be affected by the plant's water use during periods when the lake level is low and makeup water is obtained from the Neosho River. For the Wolf Creek plant, the water use conflict impact is SMALL to MODERATE and a site-specific condition. For future license renewals, the potential range of impact levels at plants with cooling ponds or cooling towers using makeup water from a river with low flow cannot be determined at this time. The impact of water use conflicts with stream communities is considered a plant-specific Category 2 issue.

Effects on Aquatic Resources (Non-Cooling System Impacts)

Impacts on aquatic resources from continued operations and refurbishment activities could occur at all operating nuclear power plants during the license renewal term as a result of (1) direct disturbance of aquatic habitats within project areas, (2) sedimentation of nearby aquatic habitats as a consequence of soil erosion, (3) changes in water quantity or water quality (e.g., grading that affects surface runoff patterns or depletions or discharges of water into aquatic habitats), or (4) releases of chemical contaminants into nearby aquatic systems. In some cases, impacts have a potential to continue to occur throughout the period covered by license renewal. In the 1996 GEIS, the NRC considered only the impact of refurbishment on aquatic habitats and concluded that the impact would be SMALL for all nuclear plants (i.e., a Category 1 issue).

The surface area disturbed during construction of new waste storage facilities (e.g., ISFSIs) would be expected to range from about 2.5 to 10 ac (1 to 4 ha). Other supporting activities that could occur at specific sites may include the construction of new parking areas for plant employees, utility corridors, access roads, or new buildings or facilities, or the demolition of existing buildings. Land used for equipment storage, worker parking, and material laydown areas could result in disturbance to aquatic resources within the plant boundaries. Surface water habitats could also be affected by draining ponds, blocking or redirecting streams, or placing rip-rap along shorelines. Depending on the size and nature of the water body, and other project-specific aspects, organisms within the affected habitats could be displaced or killed, or the community structure within the water body could be altered.

The potential for soil erosion and sediment loading of nearby aquatic habitats is typically proportional to the amount of surface disturbance, erosion potential of the soil, slope, condition of disturbed areas at any given time, and proximity to aquatic habitats. Ground-disturbing activities have a higher erosion potential. Mitigation measures include controlling surface runoff with ditches, berms, and sedimentation basins; prompt revegetation to control erosion; stockpiling and reusing excavated topsoil; and various other techniques used to control soil erosion and water pollution. These mitigation measures (often referred to as BMPs) are expected to be implemented as part of project activities undertaken during the license renewal term to minimize impacts on surface water quality and aquatic resources.

During refurbishment, effluent discharges from the cooling system of a nuclear power plant would either remain similar to those occurring during normal operations during refurbishment or would decrease if the plant was partially or totally shut down. Consequently, effects of changes in water withdrawals and discharges during refurbishment would be of SMALL significance. The impact on aquatic biota from water use would not be expected to substantially change during refurbishment or maintenance activities from the impact during existing operations.

During ground-disturbing activities, contaminants could enter aquatic habitats as a result of runoff from project sites or from accidental releases of fuels or lubricants. The level of impacts from releases of toxicants would depend on the type and volume of chemicals entering the waterway, the location of the release, the nature of the water body (e.g., size, volume, flow rates, and water chemistry), and the types and life stages of organisms present in the affected area. In general, lubricants and fuel would not be expected to enter waterways as long as construction machinery and fuel storage areas and fueling locations were located away from water bodies, and spill prevention and control measures are in place.

Obstructions to fish movement could occur in streams with low flows. Restrictions on fish movement would likely be most significant if they occurred in streams that supported species that need to move to specific areas in order to reproduce.

The impact of refurbishment on aquatic habitats was evaluated in the 1996 GEIS and considered a Category 1 issue. Permits from various Federal, State, and local governmental authorities are typically required for ground-disturbing activities. For example, refurbishment may require the issuance of permits under Section 404 of the CWA if the activities were to directly affect aquatic habitats. With proper application of environmental reviews, permitting processes, and BMPs, impacts on sensitive aquatic habitats would likely be avoided. The NRC concludes that the impact of continued operations and refurbishment activities on aquatic resources is SMALL and is considered a Category 1 issue.

Impacts of Transmission Line ROW Management on Aquatic Resources

Impacts on aquatic resources from transmission line ROW management could occur as a result of the direct disturbance of aquatic habitats, soil erosion, changes in water quality (from sedimentation and thermal effects), or inadvertent releases of chemical contaminants from herbicide use. These impacts could occur throughout the license renewal term. The NRC did not evaluate the impact of transmission line ROW maintenance on aquatic biota in the 1996 GEIS, but this issue has been identified by the NRC for consideration in this GEIS revision on the basis of past environmental reviews conducted for plant-specific SEISs.

Water quality impacts could result from maintaining transmission line ROWs and, as necessary, service roads. Where access roads cross or border on surface waters, soil erosion could cause elevated turbidity and sedimentation. Application of appropriate control techniques (e.g., establishing and maintaining vegetated buffer strips between the road and the body of water) would reduce impacts. Because ROWs are normally maintained by mowing, selective cutting, and/or selective application of herbicides, soil erosion from transmission line corridors should not normally be a problem. Potential toxic effects of herbicides that are applied to transmission line ROWs and subsequently transported to surface waters should be considered in the ROW maintenance program. By using herbicides approved for ROW use in accordance with the Federal Insecticide, Fungicide, and Rodenticide Act, significant adverse effects of herbicides on aquatic ecosystems should be minimized. Maintenance activities in the vicinity of stream and river crossings employ procedures to minimize erosion and shoreline disturbance (e.g., control of vegetation within streamside buffer zones is generally accomplished by manual techniques) while encouraging small tree, shrub, and other low-growth vegetative cover. The nature or frequency of these activities is not expected to change substantially during the license renewal term.

For small streams in particular, trees may have grown sufficiently between cutting cycles to provide stream shading. Removal of these trees to maintain required conductor clearance could increase water temperature. Coldwater species may avoid such areas. The normal reaction of fish exposed to stressful temperatures is to move along the temperature gradient until preferred temperatures are encountered. Fish could avoid elevated temperatures within the opened ROW by swimming upstream or downstream to areas of groundwater inflow, to deep holes, or to shaded areas. However, effects that result in avoidance of specific areas by some species could represent a partial loss of available habitat. Thermal conditions of larger streams (e.g., those that are 10 ft [3 m] wide or wider) would be generally unaltered, since they are mostly unshaded.

Most transmission line ROWs are maintained on a 3- to 6-year cycle, so impacts on a water body would be infrequent. Any adverse impacts would be localized and temporary and would occur primarily on small streams. To minimize potential impacts from siltation and sedimentation, herbicide application, and stream warming, the licensee or owner of the transmission line typically adheres to standard mitigation practices (application of herbicides according to label instructions and by licensed personnel) listed in the vegetation management plan. Most operators establish stream buffer setbacks within which herbicides cannot be applied, and most widely used herbicides (e.g., glyphosate, fosamine, and imazapyr) pose minimal risks to aquatic organisms.

Changes in aquatic species diversity, abundance, or health from transmission line ROW maintenance are likely to be SMALL. The continued use of proper management practices with respect to soil erosion and application of herbicides is expected. Consequently, it is anticipated that the impact of transmission lines on surface water quality and aquatic resources would be SMALL. The decision to renew the license for a specific plant would affect only the portion of the transmission line that connects the power plant to the first substation. In many cases, the first substation is within or near the boundary of the plant property, and only a short distance of transmission line would be affected by the license renewal decision. Consequently, the amount of aquatic habitat crossed by this portion of a transmission line is also likely to be SMALL.

The impact on aquatic resources of maintaining transmission line ROWs was not identified as an issue in the 1996 GEIS. However, the impact is expected to be SMALL, short term, and localized. The NRC concludes that the impact of transmission line ROW maintenance on aquatic resources would be SMALL for all nuclear plants and is considered a Category 1 issue.

Losses from Predation, Parasitism, and Disease Among Organisms Exposed to Sublethal Stresses

Sublethal power plant stresses may alter predator-prey interactions in the receiving body of water, as evaluated in the 1996 GEIS. Aquatic organisms that are stunned but not killed by entrainment, impingement, or thermal effects may still suffer “indirect” mortality through increased susceptibility to predators. Numerous laboratory studies have been carried out to evaluate the level of indirect mortality that might occur following heat and cold shocks or entrainment (reviews in Cada et al. 1981; Coutant 1981). These studies have commonly demonstrated increased susceptibility to predation, but field evidence of such effects is often limited to anecdotal information such as observations of enhanced feeding activity of seagulls and predatory fish near power plant outfalls. For example, Barkley and Perrin (1971) and Romberg et al. (1974) reported increased concentrations of predators feeding on forage fish attracted to thermal plumes. Neither quantification of the levels of stress needed to increase predation rates, nor prediction of the subsequent population- and community-level effects of such changes can be made easily in the field. It is likely that operation of once-through cooling systems will cause some changes in predator-prey relationships, but the best evidence for impacts (or lack of impacts) may come from long-term monitoring of fish populations. Neither the literature reviews nor consultations with agencies and utilities (Appendix F) have revealed studies that demonstrate population- or community-level effects from power-plant-induced alterations of predator-prey relationships.

Elevated water temperatures in power plant discharges have been hypothesized to increase the susceptibility of fish to diseases and parasites. Langford (1983) cites a number of factors that could contribute to such an effect, including the tendency for fish to congregate in the heated discharge area in greater than normal concentrations, increased stresses on fish in warmer water that makes them more prone to infection, and the ability of some diseases and parasites to develop faster at higher temperatures. Additionally, it has been suggested that stress and injury from entrainment and impingement contribute to increased susceptibility of fish to disease, parasites, and predation. Coutant (1981) noted that although some studies of increased disease and parasitism in heated waters have found localized effects, most were not adequately designed to determine the significance of the effects to the overall population. The greatest risks appear to be associated with changes in animal concentrations; crowding can occur among fish that are attracted to heated effluents in the winter or that avoid heated water in the summer by occupying limited cool-water refugia. Crowding increases the chances of exposure to infectious diseases and may also lead to other stresses (decreased food supply or reduced oxygen concentrations) that increase susceptibility to disease (Coutant 1987). Despite limited laboratory studies that confirm this phenomenon, population-level effects in the vicinity of plants have not been observed.

Impact levels due to sublethal stresses on the susceptibility of aquatic organisms to predation, parasitism, and disease are considered to be of SMALL significance if changes are localized and populations in the receiving water body are not reduced. Based on reviews of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft GEIS, these forms of indirect, power plant-induced mortality have not been shown to cause reductions in the overall populations near any existing nuclear power plants. Levels of impact are SMALL for all plants reviewed. Although sublethal power plant stresses contribute to cumulative impacts experienced by aquatic biota, monitoring has revealed no evidence for significant effects; the regulatory and resource agencies consulted in the preparation of this GEIS did not express concerns about the contribution of sublethal power plant stresses to cumulative impacts.

On the basis of its review, the NRC concludes that the level of impact due to sublethal stresses has been SMALL at plants reviewed and expects it to be SMALL for all nuclear plants. The issue remains Category 1.

4.6.1.3 Special Status Species and Habitats

Threatened, Endangered, and Protected Species and Essential Fish Habitat

The impacts associated with continued nuclear power plant operations and refurbishment activities during the license renewal term that could affect threatened, endangered, and protected species, critical habitat, and essential fish habitat (EFH) are similar to those described for terrestrial resources (Section 4.6.1.1) and aquatic resources (Section 4.6.1.2). Continued operations during the license renewal term would be expected to include such stressors as operation of cooling towers, operation of once-through cooling systems and cooling ponds, transmission line ROW management, maintenance of site facilities, releases of gaseous and liquid effluents, withdrawal of surface water, and potentially refurbishment activities. Details are presented in Section 3.6.3. There are several Federal Acts that provide protection to certain species and habitats that are treated here under a single issue. The issue includes impacts to biological resources such as threatened and endangered species and their critical habitat under the ESA, EFH as protected under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and impacts to mammalian species protected under the Marine Mammal Protection Act.

Terrestrial Species

Continued operations and refurbishment activities at all nuclear plants could have an impact on Federally or State-listed threatened and endangered species during the license renewal term. Factors that could potentially result in impacts on listed terrestrial species include habitat disturbance, cooling tower drift, operation and maintenance of cooling systems, transmission line ROW maintenance, collisions with cooling towers and transmission lines, and exposure to radionuclides. In the 1996 GEIS, the NRC considered the impacts of refurbishment and continued operation on threatened and endangered terrestrial species and concluded that the impacts would not necessarily be the same at all sites (i.e., a Category 2 issue) and could range from SMALL to LARGE.

Federally listed threatened and endangered terrestrial species are protected under the ESA, while State-listed species are protected under provisions of various State regulations. Prior to license renewal, the NRC must consult with the USFWS to determine the presence of any Federally listed species or critical habitat at or near the site and assess the potential for impacts from continued operation of the plant or associated transmission lines. The impacts of refurbishment activities on threatened or endangered species must also be considered during project planning, and consultation with the USFWS must be initiated if the possibility for impacts exists. Guidance for the consultation process is provided in the *Endangered Species Consultation Handbook* (USFWS and NMFS 1998).

Site-specific factors related to continued operations and refurbishment activities may vary widely among nuclear power plants. The listed species on or in the vicinity of nuclear power plants also range widely, depending on numerous factors such as the plant location and habitat types present (see Section 3.6.3.1). In addition, the list of threatened and endangered species is not static and is frequently modified by the USFWS and NMFS, with new listings being added as some species are determined to be eligible, other species being delisted (removed from the list), or the listing category of some species being changed because of changes in the status of or threats to the species population. Therefore, a generic determination of potential impacts on listed species during a nuclear power plant's license renewal term is not possible. Impacts on threatened and endangered species would depend on site-specific factors, and impact assessments would need to be conducted on a site-specific basis. Nuclear plants known to support terrestrial listed species on the site or along transmission line ROWs generally have monitoring programs to identify changes in populations and report impacts to the USFWS and State agencies. Monitoring provides information that can be used for developing or adjusting mitigation during the license renewal term.

Aquatic Species and Essential Fish Habitats

Potential impacts of continued operations and refurbishment activities on Federally or State-listed threatened and endangered species, protected marine mammals, and EFH could occur during the license renewal term. This issue applies to all operating nuclear power plants. Factors that could potentially result in impacts to these species and habitats include impacts of refurbishment, other ground-disturbing activities, release of contaminants, effects of cooling water discharge on dissolved oxygen, gas supersaturation, eutrophication, thermal discharges, entrainment, impingement, reduction in water levels due to the cooling system operations, dredging, radionuclides, and transmission line ROW maintenance. In the 1996 GEIS, the NRC considered potential impacts on threatened and endangered aquatic species from the operation of all nuclear power plants as a Category 2 issue and concluded that the impacts could range from SMALL to LARGE.

Power plants (nuclear and otherwise) that use estuarine or marine waters for cooling could entrain or impinge sea turtles (National Research Council 1990). The impingement mortality of sea turtles (all of which are Federally listed) has received the most attention to date with regard to the effects of nuclear power plant operations on listed species. Sea turtles are commonly encountered at some coastal nuclear plants, including the St. Lucie plant in Florida, the Oyster Creek plant in New Jersey, and the Brunswick plant in North Carolina. Between 1977 and 1997, the average number of sea turtles removed from the intake canal at the St. Lucie plant was 266 per year (Gunter et al. 2001). These included loggerhead, green, leatherback, hawksbill, and Kemp's ridley sea turtles. Most were loggerhead and green sea turtles, with an average of 150 and 103 removed per year, respectively. Among the sea turtles removed, about 4 percent of the loggerheads, 2 percent of the green, and 13 percent of the Kemp's ridley sea turtles were dead (Gunter et al. 2001). Sixty-eight sea turtles were impinged on intake screens at the Oyster Creek plant between 1992 and 2005, and 28 (41 percent) of those individuals died (NRC 2007c). The incidental take limit established by the NMFS for Kemp's ridley sea turtles was exceeded at the Oyster Creek plant in 2004, which required re-initiation of ESA Section 7 consultation with the NMFS (NRC 2007c). All three sea turtle species have been collected, as recently as 2004, in the vicinity of the Brunswick plant intake canal in North Carolina (NRC 2006e). Seventy-five percent of these turtles were released unharmed to the ocean or transported to a sea turtle facility for rehabilitation. Special panels have been installed at the diversion structure of the Brunswick plant, located at the entrance to the intake canal, to minimize the potential for sea turtles to enter the intake canal (NRC 2006e).

The licensees of the St. Lucie, Oyster Creek, and Brunswick plants have also implemented programs to monitor the intake canals for sea turtles and to capture and release to the wild any sea turtles observed in the intake canals (NRC 2003a, 2007c, 2006e). In addition, the licensee of the St. Lucie plant has initiated programs to monitor turtle nests on nearby beaches and has implemented facility lighting restrictions (NRC 2003a). Incidental takes of sea turtles have also been recorded for other plants that use estuarine or marine waters for cooling, including the Crystal River and Salem plants (Sackschewsky 2004). Sea turtles also have the potential to occur in the vicinity of other nuclear power plants located near estuarine or marine ecosystems, including the Calvert Cliffs, Diablo Canyon, Hope Creek, and Millstone plants (Sackschewsky 2004). In the SEISs prepared for the Calvert Cliffs plant (NRC 1999b) and the Millstone plant (NRC 2005c), it was determined that continued operations would not adversely affect endangered sea turtles.

Many nuclear plants whose operations are known to affect special status aquatic species have been required to establish monitoring programs and implemented mitigations in consultation with the USFWS or NMFS. For some plants, NMFS or FWS have developed incidental take limits to ensure that effects on species do not exceed specific levels. If takes exceed these incidental take limits, the NRC would be required to reinitiate consultation with USFWS or NMFS. Continued implementation of these actions would reduce the potential for adverse impacts to listed species during the license renewal term.

Prior to license renewal, the NRC consults with the USFWS and NMFS to determine the presence of and possible impacts on any ESA-listed aquatic species. Guidance for the ESA consultation process is provided in the *Endangered Species Consultation Handbook* (USFWS and NMFS 1998). The NRC also contacts the NMFS for license renewal applications for plants located in areas that may contain EFH for Federally managed marine or anadromous fisheries or for plants that may have an effect on protected marine mammals. In addition, the appropriate State agencies are contacted to determine the potential for State-listed species to be affected by continued operations and refurbishment activities during the license renewal term.

Subsequent consultation could be required for specific maintenance or refurbishment activities undertaken at a plant during the license renewal term.

Site-specific factors related to operations and refurbishment varies widely among nuclear power plants. The special status aquatic species and habitats in the vicinity of nuclear power plants and their transmission lines also vary widely, depending on numerous factors such as the plant location and habitat types present (see Section 3.6.3.2). In addition, the lists of special status species and habitats are not static and are frequently modified by the USFWS, NMFS, and State agencies, with new listings being added as some species are determined to be eligible, other species being delisted (removed from the list), or the listing category of some species being changed because of changes in the status of or threats to the species population. EFH designations and status also can change through time. Therefore, a generic determination of potential impacts on species and habitats during a nuclear power plant's license renewal term is not possible. Impacts on special status species and habitats would depend on site-specific factors, and impact assessments would need to be conducted on a site-specific basis in the plant-specific SEISs prepared for license renewal applications.

In preparing this revised GEIS, the NRC staff has determined that the levels of impact that it developed to implement the National Environmental Policy Act (NEPA) (i.e., SMALL, MODERATE, or LARGE) are not sufficiently clear with respect to the ESA and MSA, as these laws define and require other findings. So, in complying with the ESA, the NRC will report in its plant-specific environmental reviews and future SEISs the effects of continued operations and refurbishment in terms of its ESA findings of (1) no effect, (2) not likely to adversely affect, (3) likely to adversely affect, or (4) is likely to jeopardize the listed species or adversely modify the designated critical habitat of Federally listed species populations or their critical habitat. For listed species where the NRC has found that its action is "likely to adversely affect" the species or habitat, the NRC may further characterize the effects as "is [or is not] likely to jeopardize listed species or adversely modify designated critical habitat." Similarly, in complying with the MSA, the NRC will report the effects of continued operations and refurbishment in terms of its MSA findings of (1) no adverse impact, (2) minimal adverse impact, or (3) substantial adverse impact to the essential habitat of Federally managed fish populations during the license renewal term.

On the basis of these considerations, the NRC concludes that the impact of continued operations and refurbishment activities on threatened, endangered, and protected species and habitats as well as essential fish habitat would depend on plant-specific design and operating characteristics, environmental review procedures established for ground-disturbing activities, the occurrence of species and habitats, and other site-specific considerations. Consequently, this issue remains a plant-specific, or Category 2, issue.

4.6.2 Environmental Consequences of Alternatives to the Proposed Action

Construction—For all alternatives discussed in this section, the impacts of construction on ecological resources would be qualitatively similar. Ecological impacts are site-dependent. Impacts would depend on the type and location of a proposed facility, the technologies to be employed, the size of the area affected, and the specific ecological characteristics of the area to be developed. Vegetation would be removed from construction and material storage areas, and along utility pathways. Some disturbed areas would be re-vegetated after plant construction. Native vegetation could be displaced by invasive species in areas disturbed by construction. Some areas near access roads may be affected by the release of fugitive dust.

Construction-related noise could disturb wildlife. Permanent habitat loss could occur for some species. Despite reclamation efforts, a certain amount of natural habitat at greenfield sites could be permanently lost. Industrial development at brownfield and existing nuclear power plant sites have already affected or altered the natural habitat.

Operations—Various impacts on ecological resources can be anticipated throughout the operating period of an electrical power plant. Impacts include fugitive dust; impingement and entrainment of fish and other aquatic organisms; heated effluent from cooling water discharge and blowdown; gasifier and boiler blowdowns; steam water treatment; cooling tower drift (fogging and ice); salt deposition; maintenance of transmission line ROWs; bird collisions; and wildlife avoidance behavior due to operational activities and noise. Aquatic ecosystems would be affected by cooling water discharge, steam-cycle blowdown, and other (NPDES-permitted) wastewater. Onsite maintenance, accumulation of contaminants in sediment or biota, changes in levels of dissolved oxygen in surface water, dredging, and possible deposition of radionuclides would also impact aquatic resources. The magnitude of potential impacts from a proposed facility could be greater than or less than renewing the license for an existing facility depending upon site-specific and project-specific factors.

4.6.2.1 Fossil Energy Alternatives

Operations—Many of the potential ecological impacts from operations of a fossil energy facility (coal- or gas-fired) would essentially be similar to those for a nuclear facility.

Unique features of a coal-fired power plant that could impact ecological resources include:

- Coal delivery, cleaning and storage—periodic maintenance dredging (if coal is delivered by barge), noise, dust, loss of habitat, sedimentation and turbidity, and introduction of minerals and terrace elements (including contaminants that can cause impacts similar to acid mine drainage);

- Limestone preparation and storage—dust and runoff can affect soil and vegetation and increase water hardness and turbidity;

- Air emissions—most notably, acid precipitation can cause direct and indirect effects on terrestrial and aquatic organisms including injury to foliage, leaching of nutrients, decreased biodiversity, and elimination of certain fish species from lakes and streams; and

- Disposal of combustion wastes—habitat loss and potential seepage of trace and other elements into groundwater, soils, and surface waters.

The unique feature of a gas-fired power plant that could impact ecological resources would be the need for a gas pipeline. The main impact of a pipeline would be the loss, modification, and fragmentation of habitat.

Overall, ecological impacts from a fossil energy facility would depend on whether it would be located at a new site or replace an existing energy facility and whether the fossil energy facility would use once-through or closed-cycle cooling. The range of ecological impacts would be SMALL to MODERATE at an existing industrial site using closed-cycle cooling to MODERATE to LARGE at a new location using open-cycle cooling.

4.6.2.2 New Nuclear Alternatives

Operations—Since 1997, the NRC has certified four new standard designs for light-water nuclear power plants under 10 CFR Part 52, Subpart B. Therefore, impacts on ecological resources from construction and operation of a new nuclear power plant are considered in this section. The NRC assumes that the new nuclear reactor would have a 40-year lifetime. The extent of ecological impacts would depend on the location of the facility. A new nuclear plant located at the site of the existing nuclear facility would limit the amount of habitat disturbance that would be required (e.g., a new reactor at an alternative site would require about 500 to 1,000 acres [202 to 405 ha]). Additionally, existing transmission facilities, roads, parking areas, and possibly cooling system could be used if the new nuclear facility is located at the site of the existing facility. Ecological communities would experience reduced productivity and biological diversity from land disturbance. Regardless of whether a new reactor was constructed at an existing or alternative site, the amount of habitat disturbance would be greater than for license renewal of an existing nuclear facility.

Operational impacts on terrestrial ecology from a new nuclear reactor would be similar to those for the existing facility (Section 4.6.1.1). It is expected that a new nuclear reactor facility would use a closed-cycle cooling system. If the existing nuclear facility had once-through cooling, then impacts on aquatic resources for the new nuclear reactor would be reduced. Otherwise, operational impacts on aquatic ecology would be similar.

Overall, the ecological impacts of the nuclear alternative would be SMALL to MODERATE at an existing site and MODERATE to LARGE at an alternative site.

4.6.2.3 Renewable Alternatives

Construction—Dams and reservoirs would alter river flow and temperature, which could affect aquatic and terrestrial resources downstream. Dams create a barrier to fish migration if fish passages are not installed. Aquatic and terrestrial resources would have to adapt to the newly created reservoir. Disruptions to the sea bottom for installation of power and communication cables would affect benthic populations and other species that rely on benthic organisms for food. Unique ecological impacts could result from construction of offshore facilities from boat traffic to and from the construction site. Other impacts include underwater noise, alteration of sediment transport and deposition patterns, and possible disruption of onshore and nearshore nesting areas.

Operations—The operational impacts of alternative energy technologies on terrestrial and aquatic ecology are summarized in the following subsections.

Hydroelectric Energy Sources

Downstream conditions could be affected by dam operations (store-and-release of water) that could vary river flow conditions. Aquatic and terrestrial resources would be affected by fluctuating water levels downstream of the dam. Aquatic organisms could become stranded temporarily when river levels are lowered. Temperature and nutrient stratification in the reservoir and reduced levels of dissolved oxygen could result in hypotoxic or anoxic conditions for aquatic organisms. Aquatic and riparian ecosystems downstream would be affected by a variety of dam-induced conditions, such as changes in sediment transport and deposition patterns, and channel erosion or scouring. Hydropower operations could enhance populations of nonnative aquatic biota and riparian plants.

Geothermal

Birds and bats could be affected by contact with geothermal fluids temporarily stored in surface impoundments.

Wind

Aerodynamic and mechanical noise from wind turbines would affect wildlife. Collisions with wind turbines would increase bird and bat mortality. However technological advances allow rotors to turn at lower speeds, thus reducing the potential for bird and bat strikes. Underwater noise impacts from offshore facilities would extend to great distances due to the density of water. Offshore facilities could impact threatened and endangered species, marine mammals, birds, or sea turtles. Other impacts include disturbance of nesting areas, alteration of key habitat, underwater noise, or fuel spills.

Biomass

Habitat loss could occur from the cultivation of energy crops. Deposition of toxic constituents from municipal solid waste feedstock could affect aquatic and terrestrial ecosystems.

Solar Thermal and Photovoltaic

Solar fields occupy large areas of land that could reduce or preclude natural vegetation communities and wildlife use. Synthetic organic heat transfer fluids could affect surrounding vegetation. Misalignment of mirrors could also increase fire risk.

Ocean Wave and Current

Boat traffic, noise, navigation safety lights, inspection and maintenance activities could affect marine mammals, fish, and sea turtles. Sea turtles could be affected by wave-topping devices. Onshore nesting areas could be affected. Fish, sea turtles, and marine mammals could collide with underwater turbines.

4.7 Historic and Cultural Resources

4.7.1 Environmental Consequences of the Proposed Action—Continued Operations and Refurbishment

Section 106 of the National Historic Preservation Act requires Federal agencies to take into account the effects of their undertakings (license renewal) on historic properties. As discussed in Section 3.7.1, the NRC fulfills its Section 106 requirements through the NEPA process (see 36 CFR 800.8). In license renewal, only one impact issue is evaluated:

- Historic and cultural resources; issue encompasses the impact of continued operations and refurbishment activities on historic properties located onsite and in transmission line

ROWs (issue was modified and renamed from the1996 GEIS issue, “Historic and archaeological resources”).

This issue was addressed in the 1996 GEIS; however, the process for considering historic properties has been updated, and the range of historic properties has been expanded to include traditional cultural properties.

Many facilities were constructed prior to the implementation of Section 106 regulations; therefore, many nuclear plant sites were not investigated for the presence of historic and cultural resources prior to construction. As most licensees are not aware of the presence or status of historic and cultural resources on their site, a review of the site and plant activities since construction should be conducted by qualified cultural resource professionals and approved by the appropriate State Historic Preservation Office (SHPO). A variety of historic and cultural resources can be found at plant sites. Archaeological sites are generally identifiable only through field investigations. Traditional cultural properties (TCPs), historic and cultural resources that are important for a community to maintain its cultural heritage, can also be found in the immediate environs of a nuclear power plant. In some cases, the nuclear power plant itself may be considered a historic property for its design or engineering. Ultimately, historic and cultural resources at each site can be quite different and must be assessed at a plant-specific level and in consultation with SHPOs, Tribal representatives, and other interested parties.

The NRC will identify historic and cultural resources within a defined Area of Potential Effect (APE). The license renewal APE is the area that may be impacted by land-disturbing, or other operational, activities associated with continued plant operations and maintenance during the license renewal term and/or refurbishment. The APE typically encompasses the nuclear power plant site, its immediate environs including viewshed, and the transmission lines within this scope of review (see Sections 3.1.1 and 3.1.6.5 in this GEIS). The APE may extend beyond the nuclear plant site and transmission lines when these activities may affect historic and cultural resources. This determination is made irrespective of land ownership or control. If any historic properties are present, their significance is determined through application of the *National Register of Historic Places* (NRHP) criteria.

Continued operations during the license renewal term and refurbishment activities at a nuclear power plant can affect historic and cultural resources through (1) ground-disturbing activities associated with plant operations and ongoing maintenance (e.g., construction of new parking lots or buildings), landscaping, agricultural or other use of plant property, (2) activities associated with transmission line maintenance (e.g., maintenance of access roads or removal of danger trees), and (3) changes to the appearance of nuclear power plants and transmission lines. Licensee renewal environmental reviews have shown that the appearance of nuclear power plants and transmission lines have not changed significantly over time; therefore additional viewshed impacts to historic and cultural resources are not anticipated.

Extensive ground-disturbing activities occurred during nuclear power plant construction at nuclear power plant sites, and much of the land immediately surrounding the power block was disturbed down to bedrock. This activity would have eliminated any potential for historic or cultural resources to be present in this portion of the power plant site. However, to effectively determine areas that could potentially contain historic and cultural resources, a survey of any area which may be disturbed by continued operations during the license renewal term or by refurbishment associated with license renewal, including previously disturbed areas of the nuclear power plant site (other than the land immediately surrounding the power block), should be conducted by qualified professionals and in consultation with the appropriate SHPO and other consulting parties.

In the 1996 GEIS, the NRC considered the impact of continued operations and refurbishment on historic and archaeological resources at nuclear power plants and concluded that impacts would not be the same at all plants (i.e., a Category 2 issue) and could range from SMALL to LARGE. Subsequent license renewal environmental reviews conducted by the NRC support the Category 2 designation.

The National Historic Preservation Act of 1966 (NHPA) requires the NRC to conduct a site-specific assessment to determine whether historic properties are present in the APE, and if so, whether the license renewal decision would result in any adverse effect upon such properties. Thus, the NRC concludes that it is more appropriate to make one of the following determinations in its plant-specific environmental reviews instead of assigning a significance level (i.e., SMALL, MODERATE, or LARGE): (1) no historic properties present; (2) historic properties are present, but not adversely affected; or (3) there is an adverse effect on a historic property. On the basis of these considerations, the impact of continued operations and refurbishment activities on historic properties (and cultural resources) remains a Category 2 issue.

4.7.2 Environmental Consequences of Alternatives to the Proposed Action

Construction—Impacts to historic and cultural resources from the construction of a replacement power facility are primarily related to ground disturbance and are dependent on the location of the power plant. Before constructing a new replacement power plant or a facility at a greenfield, brownfield, or existing nuclear power plant site, a historic and cultural resource inventory would need to be performed by a qualified cultural resource professional. Any land needed to support the replacement power plant including roads, transmission corridors, rail lines, or other ROWs would also need to be surveyed for historic properties.

4.7.2.1 Fossil Fuel Alternatives

Operations—Ground-disturbing activities during power plant operations and maintenance could impact historic and cultural resources at the power plant site. Other ongoing activities at the power plant site could also affect historic and cultural resources. These activities include, but are not limited to, grading, excavating, landscaping, and operating large vehicles over previously undisturbed portions of the site.

4.7.2.2 New Nuclear Alternatives

Operations—Ground-disturbing activities during power plant operations and maintenance could impact historic and cultural resources at the power plant site. Other ongoing activities at the power plant site could also affect historic and cultural resources. These activities include, but are not limited to, grading, excavating, landscaping, and operating large vehicles over previously undisturbed portions of the site.

4.7.2.3 Renewable Alternatives

Hydroelectric Energy Sources

Operations—Fluctuations of river flow could erode embankments affecting downstream historic properties. Ground-disturbing activities during power plant operations and maintenance could impact historic and cultural resources at the dam site. It is assumed that impacts to historic properties would have been addressed prior to construction.

Wind

Operations—Historic properties would be affected by the presence of wind turbines in the viewshed. Ground-disturbing activities during power plant operations and maintenance could impact historic and cultural resources at the wind farm site. It is assumed that impacts to historic properties would have been addressed prior to construction.

Ocean Wave and Current

Operations—Historic properties located offshore could be affected by kinetic energy by ocean wave and/or current-energy-capturing devices. Ground-disturbing activities during power plant operations and maintenance could impact historic and cultural resources on the ocean floor. It is assumed that impacts to historic properties would have been addressed prior to construction.

Geothermal, Biomass, and Solar Thermal and Photovoltaic

Operations – Ground-disturbing activities during power facility operations and maintenance could impact historic and cultural resources at the power plant site. Other ongoing activities at the power facility site could also affect historic and cultural resources. These activities include, but are not limited to, grading, excavating, landscaping, operating large vehicles over previously undisturbed portions of the site.

4.8 Socioeconomics

4.8.1 Environmental Consequences of the Proposed Action—Continued Operations and Refurbishment Activities

The socioeconomic impact of ongoing power plant operations has become well established during the current license term for all nuclear power plants. Changes in employment and tax payments caused by license renewal and associated refurbishment activities can have a direct and indirect effect on community services and housing demand, as well as traffic volumes in the communities around each nuclear power plant.

A review of license renewal applications provides no evidence that the number of permanent power plant operations workers would increase during the license renewal term. This differs from the conservative assumption that up to 60 additional workers per reactor unit (upper bound) could be needed to support aging management-related maintenance and inspection activities (see 1996 GEIS). Licensees, however, indicated that they had no plans to add non-outage workers during the license renewal term and that increased maintenance and inspection activities could be managed using the current workforce. This review also revealed that refurbishment activities, such as steam generator and vessel head replacement, have not required the large numbers of workers and months of time that was conservatively predicted in the 1996 GEIS. Therefore, people living in the vicinity of a nuclear power plant are not likely to experience any changes in socioeconomic conditions during the license renewal term beyond what is currently being experienced. In addition, refurbishment impacts are expected to be similar to what has been experienced during regularly scheduled power plant refueling and maintenance outages.

The environmental review conducted for this GEIS revision identified five socioeconomic impact issues, which include all of the original socioeconomic license renewal term and refurbishment impact issues addressed in the 1996 GEIS. These five issues are:

- Employment and income, recreation and tourism (new, consolidated issue that adds impacts on employment and income that were not addressed in the 1996 GEIS). Also included in this issue are the impacts on recreation and tourism (impacts on tourism and recreation were addressed in the 1996 GEIS as part of the issue, "Public services: public safety, social services, and tourism and recreation");

- Tax revenues (new issue; issue was considered and discussed in the 1996 GEIS, but not identified as a separate environmental review issue);

- Community services and education (consolidation and reclassification of the following issues in the 1996 GEIS: (1) public services: public safety, social services [excluding public services: tourism and recreation]; (2) public services: public utilities; (3) public services: education [license renewal term]; and (4) public services: education [refurbishment]);

- Population and housing (issue was reclassified and renamed from the 1996 GEIS issue, "Housing impacts"; these impacts were considered in the 1996 GEIS, although the population impacts component was not identified as a separate issue); and

- Transportation (issue was reclassified and renamed from the 1996 GEIS issue, "Public services: transportation").

4.8.1.1 Employment and Income, Recreation, and Tourism

As discussed in Chapter 3, the nuclear power plant and the communities that support it can be described as a dynamic socioeconomic system. The communities provide the people, goods, and services required to operate the nuclear power plant. Power plant operations, in turn, provides employment and income and pays for goods and services from the communities.

Employees receive income from the nuclear power plant in the form of wages, salaries, and benefits. Employees and their families, in turn, spend this income on goods and services within the community thereby creating additional opportunities for employment and income. In addition, people and businesses in the community receive income for the goods and services sold to the power plant. Payments for these goods and services create additional employment and income opportunities in the community. The measure of a communities' ability to support the operational demands of a power plant depends on the ability of the community to respond to changing socioeconomic conditions.

As previously discussed, it is unlikely that the number of power plant operations workers would change at a nuclear power plant during the license renewal term. While it was conservatively estimated in the 1996 GEIS that up to 60 additional workers per unit could be required during the license renewal term, subsequent license renewal environmental reviews have shown little or no need to hire additional operations workers. In addition, refurbishment activities, such as steam generator and vessel head replacement, have not required the numbers of workers and the months of time conservatively estimated in the 1996 GEIS. Consequently, employment levels at a nuclear power plant are not expected to change as a result of license renewal.

Some communities experience seasonal transient population growth due to local tourism and recreational activities. Income from tourism and recreational activities creates employment and income opportunities in the communities around nuclear power plants. Communities located near nuclear power plants in coastal regions, notably Pilgrim near Plymouth and Cape Cod, Massachusetts; the D.C. Cook and Palisades plants on the eastern shore of Lake Michigan, and the Oyster Creek plant on the New Jersey shore north of Atlantic City, experience summer, weekend, and retirement population increases due to the recreational and tourism activities that attract visitors. Some communities, such as those located in the region around the Vermont Yankee plant in Vermont, attract visitors interested in outdoor recreational activities, such as camping, hiking, and skiing.

As discussed in Section 4.2.1.2, the NRC considered the impacts of continued plant operations during the license renewal term and refurbishment on visual resources, which could affect tourism and recreational business interests. The NRC concluded in the 1996 GEIS that the impacts on visual resources would be SMALL for all plants and was a Category 1 issue, primarily because the impact had already occurred and the visual profile of nuclear power plants were not expected to change as a result of license renewal. Also, visual impacts tend to wear off over time when viewed repeatedly.

However, a case study performed for the 1996 GEIS found situations where nuclear power plants have had a negative effect on visual resources. Negative perceptions were based on aesthetic considerations (for instance, the plant is out of character or scale with the community or the viewshed), physical environmental concerns, safety and perceived risk issues, an anti-power plant (or utility) attitude, or an anti-nuclear orientation. It is believed that some of these negative perceptions would persist regardless of mitigation measures. Subsequent license renewal reviews have not revealed any new information that would change this perception.

Nevertheless, the effects of power plant operations on employment, income, recreation, and tourism are ongoing and have become well-established during the current license term for all nuclear power plants. The impacts from power plant operations during the license renewal term on employment and income in the region around each nuclear power plant are not expected to change from what are currently being experienced. In addition, tourism and recreational activities in the vicinity of nuclear plants are not expected to change as a result of license renewal. On the basis of these considerations, the NRC concludes that the impact of continued nuclear plant operations and refurbishment activities on employment, income, recreation, and tourism would be SMALL and is therefore considered a Category 1 issue.

4.8.1.2 Tax Revenues

Nuclear power plants and the workers who operate them are an important source of tax revenue for many local governments and public school systems. Tax revenues from nuclear power plants mostly come from property tax payments or other forms of payments such as payments in lieu of (property) taxes, or PILOT payments, although taxes on energy production have also been collected from a number of nuclear power plants. County and municipal governments and public school districts receive tax revenue either directly or indirectly through State tax and revenue-sharing programs.

Counties and municipal governments in the vicinity of a nuclear power plant also receive tax revenue from sales taxes and fees from the power plant and its employees. Changes in the number of workers and the amount of taxes paid to county, municipal governments, and public schools can affect socioeconomic conditions in the counties and communities around the nuclear power plant.

A review of license renewal applications received by the NRC since the 1996 GEIS has shown that refurbishment activities, such as steam generator and vessel head replacement, have not had a noticeable effect on the assessed value of nuclear plants, thus changes in tax revenues are not anticipated from future refurbishment activities. Refurbishment activities involving the one-for-one replacement of existing components and equipment are generally not considered a taxable improvement. Also, property tax assessments; proprietary payments in lieu of tax stipulations, settlements, and agreements; and State tax laws are continually changing the amount of taxes paid to taxing jurisdictions by nuclear plant owners. These changes are independent of license renewal and refurbishment activities.

The primary impact of license renewal would be the continuation or change in the amount of taxes paid by nuclear power plant owners to local governments and public school systems. The impact of nuclear plant operations on tax revenues in local communities and the impact that the expenditure of tax revenues has on the region are not expected to change appreciably from the amount of taxes paid during the current license term. Tax payments during the license renewal term would be similar to those currently being paid by each nuclear plant. On the basis of these considerations, the NRC concludes that the impact of continued nuclear plant operations and refurbishment on tax revenue would be SMALL and is therefore considered a Category 1 issue.

4.8.1.3 Community Services and Education

In the 1996 GEIS, impacts on public (community) services and education were evaluated based on the projected number of “in-migrating” workers accompanied by their families. In addition, impacts on (1) public services: public safety, social services…; (2) public services: public utilities; (3) public services, education (license renewal term); and (4) public services, education (refurbishment) were considered as separate impact issues in the 1996 GEIS but have been consolidated and reclassified under this issue. All but the “public services: tourism and recreation” component of the 1996 GEIS issue, “Public services: public safety, social services, and tourism and recreation” are considered here.

The four 1996 GEIS issues have been consolidated because all public services are equally affected by changes in nuclear power plant operations and refurbishment activities. Any changes in the number of workers at a nuclear plant will affect the demand for public services from local communities. Environmental reviews conducted by NRC since the 1996 GEIS have shown, however, that the number of workers at relicensed nuclear plants has not changed significantly because of license renewal, so demand-related impacts on community services, including public utilities, are no longer anticipated from future license renewals.

In addition, refurbishment activities, such as steam generator and vessel head replacement, have not required the large numbers of workers and the months of time that was conservatively analyzed in the 1996 GEIS, so significant impacts on community services are no longer anticipated. Because of the relatively short duration of refurbishment-related activities, workers are not expected to bring families and school-age children with them; therefore, impacts from refurbishment on educational services are also no longer anticipated.

Taxes paid by nuclear power plant owners support a range of community services, including public water, safety, fire protection, health, and judicial, social, and educational services. In some communities, tax revenues from power plants can have a noticeable impact on the quality of services available to local residents. Although many of the community services paid for by tax revenues from power plants are used by plant workers and their families, the impact of nuclear plant operations on the availability and quality of community services and education is SMALL and is not expected to change as a result of license renewal. On the basis of these considerations, the NRC concludes that the impact of continued nuclear plant operations and refurbishment activities on community services and education would be SMALL and is therefore considered a Category 1 issue.

4.8.1.4 Population and Housing

Socioeconomic impact analyses of resources (e.g., housing) affected by changes in regional population are based on employment trends at nuclear power plants. Population growth from increased employment and spending at a nuclear power plant is important because it is one of the main drivers of socioeconomic impacts. Plant-induced population growth, while not an impact itself, was studied as a potential influence on a number of impact issues analyzed in the 1996 GEIS. As previously discussed, however, employment levels at nuclear power plants are expected to remain relatively constant with little or no population growth or increased demand for permanent housing during the license renewal term. The operational effects on population and housing values and availability in the vicinity of nuclear power plants are not expected to change from what is currently being experienced, and no demand-related impacts are expected during the license renewal term.

The increased number of workers at nuclear power plants during regularly scheduled plant refueling and maintenance outages does create a short-term increase in the demand for temporary (rental) housing units in the region around each plant. However, because of the short duration and the repeated nature of these scheduled outages and the general availability of rental housing units (including portable trailers) in the vicinity of nuclear power plants, employment-related housing impacts have had little or no long-term impact on the price and availability of rental housing. Refurbishment impacts would be similar to what is experienced during routine plant refueling and maintenance outages.

License renewal reviews conducted since the 1996 GEIS have shown that housing has not been an issue at relicensed nuclear plants including those plants located in "sparsely populated areas." Therefore, impacts to these resources are no longer anticipated from future license renewals. On the basis of these considerations, the NRC concludes that the impact of continued nuclear plant operations and refurbishment activities on population and housing would be SMALL and is therefore considered a Category 1 issue.

4.8.1.5 Transportation

Transportation impacts depend on the size of the workforce, the capacity of the local road network, traffic patterns, and the availability of alternate commuting routes to and from the plant. Because most sites have only a single access road, there is often congestion on these roads during shift changes.

Nevertheless, license renewal is not likely to affect local transportation conditions in the vicinity of a nuclear power plant beyond what is currently being experienced. Transportation impacts are ongoing and have become well established during the current licensing term for all nuclear power plants. As previously discussed, it is unlikely that the number of permanent operations workers would increase at a nuclear power plant during the license renewal term. While it was estimated in the 1996 GEIS that up to 60 additional workers per unit could be required during the license renewal term, subsequent environmental reviews have shown little or no need for additional operations workers. In addition, refurbishment activities, such as steam generator and vessel head replacement, have not required the numbers of workers and the months of time conservatively estimated in the 1996 GEIS. Consequently, employment at nuclear power plants during the license renewal term is expected to remain unchanged. Refurbishment impacts would be similar to what has been experienced during routine plant refueling and maintenance outages.

The increased number of workers at nuclear power plants during regularly scheduled plant refueling and maintenance outages have caused short-term increases in traffic volumes on roads in the vicinity of each plant. However, because of the relative short duration of these outages, increased traffic volumes have had little or no lasting impact. Therefore, there would be no transportation impacts during the license renewal term beyond those already being experienced. On the basis of these considerations, the NRC concludes that the impact of continued operations and refurbishment activities on local transportation would be SMALL and is therefore considered a Category 1 issue.

4.8.2 Environmental Consequences of Alternatives to the Proposed Action

The impacts of power plant development on local and regional socioeconomic conditions would be qualitatively similar for all alternatives discussed in this section. Local economies have the potential to be directly or indirectly affected by power plant construction and operation. The power plant and the communities that support it can be described as a dynamic socioeconomic system. The communities provide the people, goods, and services required by power plant construction and operation. Activities at the plant, in turn, create the demand and pay for the people, goods, and services in the form of wages, salaries, and benefits for jobs and dollar expenditures for goods and services. The measure of the communities' ability to support the demands of the power plant depends on their ability to respond to changing environmental, social, economic, and demographic conditions.

Construction—The scale of the socioeconomic impacts of construction activities associated with each alternative would be related to the cost and complexity of the facility and the size of the workforce. The duration of the impact would be determined by the time required to complete construction. The impacts of the construction of power plants on employment and income in the local area and region around a new plant would vary depending on the location of major equipment suppliers and local labor availability. Impacts may be more dramatic and larger at greenfield sites located in rural areas than areas on the periphery of larger urban areas. Overall, construction is expected to have a temporary effect on the local economy.

While some construction workers would be local, additional workers may be required from outside the immediate area depending on the local availability of appropriate trades and occupational groups. At plants in rural locations, a larger number of construction workers would come from outside the local area, while most of the workforce in semi-urban locations would likely commute to the job site rather than relocate. Construction is likely to have some impact on local services such as public utilities, public safety, tourism, and recreation, depending on the number of workers required to in-migrate into the area around each plant. Materials needed for construction (e.g., sand, gravel, fill, etc.) are expected to be provided locally. However, the majority of construction materials and technology components are expected to be purchased in other parts of the United States or overseas. Transportation impacts during construction would include commuter and truck material and equipment delivery traffic to and from the construction site.

Operations—Operations of a new power plant would have an ongoing effect on the local economy, which would be directly or indirectly affected by power plant operation. As would be the case for construction, the impacts of the operation of power plants on employment and income in the local area and region around a new plant would vary depending on the location of major equipment suppliers and the availability of local labor. In addition, operations impacts may have a larger relative impact on communities in rural locations, with smaller relative impacts in semi-urban locations. The operations workforce would increase demand for social services, depending on the number of workers required to migrate into the area around each plant. Property values for nearby private residences could be affected positively if plant workers were to live locally. Property values could also be affected negatively, if there were impacts associated with noise, traffic, or if there were visual impacts associated with the plant.

Declining property values may mean increased local taxes to support existing levels of service in local public and educational services, which combined with declining quality of life, may lead to some population out-migration. The loss of recreational opportunity could mean the loss of employment and income in local communities hosting recreational suppliers and providing temporary accommodation. Transportation impacts would include increased commuter traffic during shift changes and deliveries of materials and equipment to the power plant.

The following sections briefly highlight socioeconomic impacts that would be characteristics of particular energy alternatives.

4.8.2.1 Fossil Fuel Alternatives

A relatively large workforce would be required to construct and operate fossil-fuel alternative-technology power plants, and, as a consequence, impacts on local employment and income and the local public and educational services that would be needed with the in-migration of workers during each phase could be large. Fossil-fuel alternatives, including natural gas- and coal-fired plants, could have substantial impacts, depending on various key aspects of each technology. Differences in stack heights and emissions between the two technologies and the transportation impacts associated with coal deliveries to the power plant (primarily by rail) and the removal of wastes and byproducts may affect property values and recreation and tourism opportunities in the vicinity of plants.

4.8.2.2 New Nuclear Alternatives

A relatively large workforce would be required to construct and operate new nuclear power plants, and, as a consequence, impacts on local employment and income and the local public and educational services that would be needed with the in-migration of workers during each phase could be large. Impacts of the construction and operation of new nuclear plants would also depend on key features of these plants. In addition to the heights of cooling towers and other tall or large structures, the existence of a nuclear power plant could affect property values and recreation and tourism through the perception of risk that people may have related to nuclear technology itself, and also the presence and visibility of nuclear waste storage facilities.

4.8.2.3 Renewable Alternatives

Operations –The impacts of alternative energy technologies on socioeconomics are presented in the following subsections. A relatively small workforce would be required to operate renewable alternative technology power plants and, as a consequence, impacts on employment and income and the local public and educational services that would occur with the in-migration of workers during each phase for each alternative technology would be SMALL.

Hydroelectric Energy Sources

Although there may be economic losses in the local area and region associated with development of hydroelectric resources, notably with the loss of agricultural land, transportation infrastructure, and recreational opportunities, the reservoir would create new recreational opportunities including parks, campgrounds, and boat ramps. Traffic in the vicinity of the dam and reservoir, typically a rural agricultural area, could increase as a result of recreational opportunities created by the reservoir.

Geothermal

Depending on the location of geothermal plants and the amount of land required for power plant development, recreation and property values in the area could be adversely affected by noise, sights, and odors from plant operations. Transportation impacts are expected to be limited, although large vehicle traffic could be required for the deployment and replacement of equipment.

Wind

Depending on the location of wind energy development, the visual impact of wind turbines, and to a lesser extent the associated noise, may have adverse impacts on recreation in the local area and on property values and quality of life in local rural communities. Transportation impacts are expected to be limited. Large vehicles could be required for the deployment and replacement of equipment.

Biomass

Truck and rail traffic bringing biomass fuel to the facility and removing solid wastes to offsite disposal facilities could impact local transportation networks and may affect property values and recreation and tourism opportunities in the vicinity of plants.

Ocean Wave and Current

Tourist and recreational activities on coastal beaches could be affected by the visual and noise impacts of helicopter and boat traffic. Wave energy devices that float on the ocean surface could affect navigation and water-borne recreational activities.

4.9 Human Health

4.9.1 Environmental Consequences of the Proposed Action—Continued Operations and Refurbishment Activities

Human health conditions at all nuclear power plants and associated transmission lines have been well established during the current licensing term. These conditions are expected to remain unchanged during the 20-year license renewal term.

4.9.1.1 Environmental Consequences of Normal Operating Conditions

This section provides an evaluation of the impacts of radiological, chemical, microbiological, EMFs, and other hazards on occupational personnel and members of the public from continued operation and refurbishment activities during the license renewal term. This evaluation extends to all U.S. commercial nuclear power reactors. For safe and reliable operation of a nuclear power plant, it is necessary to perform routine maintenance on plant systems and components. Maintenance activities conducted at nuclear power plants include inspection, surveillance, and repair and/or replacement of material and equipment to maintain the current licensing basis of the plant and ensure compliance with environmental and public safety requirements. Certain activities can be performed while the reactor is operating, and others require that the reactor be shut down. Long-term outages are scheduled for refueling and for certain types of repairs or maintenance activities, such as the replacement of steam generators for PWRs.

4.9.1.1.1 Radiological Impacts

Two environmental issues related to radiological exposure and risk are reviewed here: (1) radiation exposures to plant workers and (2) radiation exposures to the public, both of which would result from continued operation and refurbishment activities during the license renewal term. All aspects of these consolidated issues were evaluated in the 1996 GEIS, but the impacts of refurbishment were considered separately from those of operations.

For the purposes of assessing radiological impacts, impacts are considered to be SMALL if releases and doses do not exceed permissible levels in the NRC's regulations. This definition of SMALL applies to occupational doses as well as to doses to individual members of the public. Accidental releases or noncompliance with the standards could conceivably result in releases that would cause MODERATE or LARGE radiological impacts. Such conditions are beyond the scope of regulations for controlling normal operations and providing an adequate level of protection. Environmental consequences and human health effects of potential accidents are addressed in Section 4.9.1.2.

Radiation Exposures to Plant Workers

The occupational radiological exposures from current operations at nuclear power plants are discussed in Section 3.9.1.2, and the risk estimates from this radiation exposure are discussed in Section 3.9.1.4.

In the 1996 GEIS, the impacts from occupational radiological exposure from refurbishment and continued operations were evaluated separately. To estimate radiation-related impacts on workers over the license renewal term, occupational radiation exposure was used as the environmental impact initiator that was quantified. It was assumed that occupational radiation exposure would change relative to current nuclear plant operations as a result of actions taken to support license renewal. To evaluate the impacts, two types of license renewal programs were considered: a "typical" or "mid-stream" license renewal program, and a "conservative" or "bounding" program (NRC 1996). Each program applied to both PWRs and BWRs. Thus, in all, four scenarios were considered. It was assumed that activities carried out in support of license renewal would be performed primarily during selected outages. Five types of outages were considered: normal refuelings, 5-year in-service inspection (ISI) outages, 10-year ISI outages, current-term refurbishment outages, and major refurbishment outages. The potential actions and activities that would be undertaken during these outages were identified. All of the rules and regulations, in particular, the Maintenance Rule (10 CFR 50.65, "Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants"), were taken into account in developing typical license renewal or plant-life extension (NRC 1996). The occupational exposure for each of the five types of outages was estimated for all four scenarios (see Table 4.9-1).

For refurbishment efforts, dose estimates for activities during each of the four current-term refurbishment outages were 11 and 10 person-rem for PWRs and BWRs, respectively, for the typical case; and 200 and 191 person-rem, respectively, for the conservative case. Dose estimates for the assumed single period of major refurbishment were 79 and 153 person-rem for

Table 4.9-1. Additional Collective Occupational Dose (person-rem) for Different Actions under Typical and Conservative Scenarios during the License Renewal Term

Outage Type	Typical BWR	Conservative BWR	Typical PWR	Conservative PWR
Normal refueling[(a)]	4	10	3	7
5-yr ISI[(b)] refueling[(c)]	71	27	30	35
10-yr ISI refueling[(d)]	91	108	51	66
Current-term refurbishment[(e)]	10	191	11	200
Major refurbishment outage[(f)]	153	1,561	79	1,380
Total all occurrences	457	2,666	261	2,374

(a) 8 occurrences, 2-month duration each.
(b) ISI = in service inspection.
(c) 2 occurrences, 3-month duration each.
(d) 1 occurrence, 4-month duration for conservative and 3-month duration for typical scenario.
(e) 4 occurrences, 4-month duration for conservative and 3-month duration for typical scenario.
(f) 1 occurrence, 9-month for conservative and 4-month duration for typical scenario.
Source: Tables 2.8 and 2.11 in the 1996 GEIS

PWRs and BWRs, respectively, for the typical case; and 1380 and 1561 person-rem, respectively, for the conservative case. The issue was designated as a Category 1 issue in the 1996 GEIS.

For continued operations during the license renewal term, the NRC observed in the 1996 GEIS that the greatest increment to occupational dose over the present dose would occur during a 10-year ISI refueling. In a typical case, the occupational dose would increase over the present dose by 91 person-rem for a BWR and by 51 person-rem for a PWR. In a conservative case, the occupational dose would increase over the present dose by 108 person-rem and 66 person-rem, respectively, for BWRs and PWRs. It was noted that there is about an 8 percent increase in collective radiation dose over current operating experience. The individual occupational doses would be well below regulatory limits (i.e., the impact would be SMALL), and the issue was designated as a Category 1 issue.

For estimating the impacts from continued operation and refurbishment activities during the license renewal term in this GEIS revision, the occupational exposure histories for all commercial nuclear power plants were evaluated for trends.

Throughout the nuclear power industry, modification and upgrade activities have continued at each operating plant. They have included a broad range of activities in response to NRC requirements and industry initiatives, including post-Three Mile Island upgrades, radioactive waste system modifications, and spent fuel storage upgrades. In addition, several nuclear power plants have undergone major refurbishment efforts, such as PWR steam generator replacement and the replacement of coolant recirculation piping in BWRs. These activities offered a significant potential for occupational exposure. Thus, occupational exposure histories accumulated to date reflect normal operation plus modifications and additions to existing systems. This information forms the basis for evaluating the occupational doses that result from refurbishment and continued operations during the license renewal term. The data in Tables 3.9-8 and 3.9-9 show that there are variations in occupational dose from year to year, but there is no consistent trend that shows that occupational doses are increasing over time.

Since 1996, over 70 operating reactors at over 40 nuclear power plant sites have undergone an environmental review for license renewal. Many nuclear power plants have already replaced major components like steam generators during their current license term. Moreover, as part of the license renewal application, the plants have conducted an aging management review. All of the plants expect to conduct the activities related to managing impacts from aging during plant operation or normal refueling and other outages, but they do not plan any outage specifically for the purpose of refurbishment. The applicants have indicated that the activities conducted during the license renewal term are expected to be within the bounds of normal operations; thus, even the typical scenario in the 1996 GEIS can be considered conservative.

Overall, data presented in Tables 3.9-3 to 3.9-13 provide ample evidence that occupational doses at all commercial power plants are far below the occupational dose limit of 5 rem/yr established by 10 CFR Part 20 and that the continuing efforts to maintain doses at ALARA levels have been successful.

The wide range of annual collective doses experienced at PWRs and BWRs in the United States results from a number of factors, such as the reactor design, amount of required maintenance, and amount of reactor operations and in-plant surveillance. Because these factors can vary widely and unpredictably, it is very difficult to determine in advance a specific year-to-year annual occupational radiation dose for a particular plant throughout its operating lifetime. On occasion, relatively high collective occupational doses (as compared with the average annual collective dose) may be unavoidable, even at plants with radiation protection programs designed to ensure that occupational doses will be kept to ALARA levels.

During 2005, with occupational radiation protection programs in place, nuclear power plants maintained an annual average individual dose of 0.12 rem and 0.18 rem for PWRs and BWRs, respectively (Table 3.9-11), compared with an exposure limit of 5 rem. For all nuclear power plants combined, the occupational doses to individual workers are estimated to average 0.15 rem/yr (Table 3.9-4). At these dose levels, the average increase in fatal individual cancer risk to a worker is approximately 6×10^{-5}/yr (using the ICRP risk coefficient of 4×10^{-4}/rem from Table 3.9-20). If the reactor operates for 60 years, the cumulative increase in fatal cancer to an individual worker is estimated to be 3.6×10^{-3} (a 50 percent increase over the baseline of 40 years of operations). However, it is very unlikely that the same worker would be employed for all 60 years of plant operations.

The average collective occupational exposure for the year 2005 was roughly 171 person-rem per plant at BWRs and about 79 person-rem per plant at PWRs (Table 3.9-10). For 2005, 50 percent of the PWRs reported collective doses between 44 and 107 person-rem, while 50 percent of the BWRs reported collective doses between 94 and 198 person-rem (see Figure 3.9-1). For 2005, no worker received doses greater than 3 rem. Only 17 workers (0.01 percent) received an occupational dose exceeding 2 rem during 2005. At BWRs, less than 0.03 percent of the workers received doses greater than 2 rem. At PWRs, no worker received a dose greater than 2 rem, and less than 0.3 percent of the workers received doses greater than 1 rem (Table 3.9-12).

Over the years, ALARA programs continue to limit occupational doses. Occupational doses have shown a declining trend over the past 10 years and have recently leveled off. As plants age, there may be slight increases in radioactive inventories, which would result in slight increases in occupational radiation doses, but that trend has not yet appeared.

Overall, data presented in Tables 3.9-1 to 3.9-13 provide evidence that doses to nearly all radiation workers are far below the worker dose limit established by 10 CFR Part 20 and that the continuing efforts to maintain doses at ALARA levels have been successful.

It is expected that occupational doses from refurbishment activities associated with license renewal and occupational doses for continued operations during the license renewal term would be similar to the doses during the current operations and bounded by the analysis conducted in the 1996 GEIS. It is estimated that the occupational doses would be much less than the regulatory dose limits, as described above. Expected occupational radiation exposures meet the standard for being of SMALL significance. No mitigation measures beyond those implemented during the current license term would be warranted, because the ALARA process continues to be effective in reducing radiation doses. The risks to an individual worker from radiological exposure would increase by 50 percent as a result of the plant operating for 20 more years, but it is unlikely that the same worker would be employed for all 60 years of plant operations.

In the 1996 GEIS, the NRC concluded that the occupational radiological exposure impact during license renewal and refurbishment would be SMALL for all plants; it was therefore designated as a Category 1 issue. No new information has been identified in the SEISs prepared to date or the literature that would alter that conclusion. On this basis, the NRC concludes that the impact of continued operations and refurbishment activities on occupational radiological exposure would be SMALL for all nuclear plants and remains a Category 1 issue.

Radiation Exposures to the Public

Radiological exposures to the public from current operations at nuclear power plants are discussed in Section 3.9.1.3. That section includes a discussion of the effluent pathways used in calculating dose and the radiological monitoring performed by each site to ensure that unanticipated buildup of radioactivity have not occurred in the environment. The risk estimates for the public from radiation exposure are discussed in Section 3.9.1.4.

Refurbishment Activities—To determine the relative significance of the estimated public dose from refurbishment, the public dose during the year refurbishment activities occurred was compared with the doses in consecutive years. Exposure from other ongoing support activities similar to those that occurred during the current license term (e.g., construction of new parking lots, access roads, and buildings) would be less than or equal to the impacts associated with refurbishment.

In the 1996 GEIS, the NRC identified the replacement of steam generators at PWRs and the replacement of recirculation piping at BWRs as the major anticipated refurbishment activities. Public radiation exposures from refurbishment activities during the license renewal term can be evaluated on the basis of information derived from past occurrences and projections for other repairs. Effluents anticipated during major refurbishment actions were estimated on the basis of historical information derived for steam generator replacements at PWRs and replacements of recirculation piping at BWRs. These refurbishment tasks have already taken place several times within the commercial nuclear power reactor industry. From these estimates, the maximum individual dose to the member of the public was compared with the design objective of Appendix I to 10 CFR Part 50 (Table 3.9-2) and with baseline effluents produced during normal reactor operations.

Public radiation exposures from gaseous and liquid effluents produced during refurbishment can be evaluated on the basis of effluent data from the replacement of steam generators and recirculation piping. During the replacement of steam generators and recirculation piping, releases of effluents have occurred under controlled conditions and in accordance with ALARA principles. Similar refurbishment efforts that may occur as part of the license renewal process would also take place under controlled conditions and in accordance with ALARA principles.

The first several plants to replace steam generators estimated the amounts of radioactivity expected to be released in liquid and gaseous effluents as a result of the repair (Parkhurst et al. 1983). Actual effluent measurements were performed in several cases. In the 1996 GEIS, the NRC listed the radioactive effluent releases for early steam generator replacements and compared them with typical 1986 effluent releases for PWRs and BWRs (see Table 3.10 in NRC 1996). It was found that the effluent releases were approximately the same or much less than those from normal operations for a year. For BWR recirculation piping replacement, the NRC compared the annual release and dose commitment information for five reactor sites (Cooper, Monticello, Nine Mile Point, Peach Bottom, and Vermont Yankee) during recirculation piping replacement with the data from normal operations of the same plants. It was found that the radiation doses to the public were similar to or less than those resulting from normal operations (see Table 3.11 in NRC 1996). On the basis of this finding, the NRC concluded in the 1996 GEIS that gaseous effluents and liquid discharges occurring during a 9-month refurbishment action would not be expected to result in maximum individual doses exceeding the design objectives of Appendix I to 10 CFR 50 or the allowable EPA standards of 40 CFR Part 190 (Table 3.9-2).

For estimating the impacts from refurbishment activities during the license renewal term in this GEIS revision, radioactive effluent releases and the dose to the public from the gaseous and liquid effluent releases were evaluated for the three sites that have gone through steam generator replacement in recent years. The effluent releases and the doses that occurred during the year refurbishment was done are compared with the values for prior and subsequent years.

Table 4.9-2 presents the radioactive effluent releases at three sites that have had their steam generators replaced in recent years. For Arkansas Unit 2, the steam generator was replaced in 2000, and the effluent releases are listed from 1999 to 2003. For Calvert Cliffs Unit 1, the steam generator was replaced in 2002, for Unit 2, it was replaced in 2003. The effluent releases are listed from 2000 to 2004. For Palo Verde Unit 2, the steam generator was replaced in 2003. The effluent releases are listed from 2001 to 2005. For this site, there are no liquid effluent releases beyond the site boundary. The data show that the effluent releases for the year that the steam generators were replaced are on the same order of magnitude or much less than the effluent releases for the following year. The effluent releases were also much less than or on the same order of magnitude as those shown in Table 3.10 of the 1996 GEIS.

Table 4.9-3 presents the dose to the public from the gaseous and liquid effluent releases for the same three sites. No significant difference in the dose from normal operations was observed when the steam generator was replaced. All doses are much less than the design objectives shown in Table 3.9-2. Tables 4.9-2 and 4.9-3 show that effluents and dose impacts during the year when a steam generator replacement is performed do not differ significantly from those in years of normal operations.

It is expected that doses during any future recirculation piping replacement would not be much different than the doses shown in Table 3.11 in the 1996 GEIS. The NRC is updating these tables for recent year data. The NRC will also assess dose contributions from the numerous plants that have replaced reactor vessel heads.

When a major refurbishment is performed, it is expected that more work will be performed and thus the amounts of some of the effluents, especially atmospheric particulates and possibly

Table 4.9-2. Radioactive Effluent Releases for Three Nuclear Power Plants That Recently Replaced Steam Generators

	Releases (Ci) in Gaseous Effluent					Releases (Ci) in Liquid Effluent			
Year[(a)]	Fission and Activation Products	Gross Alpha	Iodines	Particulates	Tritium	Dissolved and Entrained Gases	Fission and Activation Products	Gross Alpha	Tritium
Arkansas Unit 2									
1999	3.9×10^{1}	0	0	3.9×10^{-5}	3.7×10^{1}	2.3×10^{-2}	8.5×10^{-2}	4.4×10^{-4}	5.9×10^{2}
2000	**4.5**	**3.4×10^{-7}**	**0**	**7.4×10^{-6}**	**2.0×10^{1}**	**2.1×10^{-1}**	**2.6×10^{-1}**	**1.2×10^{-1}**	**5.0×10^{2}**
2001	1.7×10^{-1}	0	0	0	2.4×10^{1}	5.0×10^{-3}	7.2×10^{-2}	8.9×10^{-4}	4.9×10^{2}
2002	4.6×10^{-1}	0	1.7×10^{-5}	0	2.8×10^{1}	5.3×10^{-2}	2.0×10^{-2}	0	5.6×10^{2}
2003	3.9×10^{-1}	0	1.0×10^{-6}	0	2.5×10^{1}	9.9×10^{-2}	3.7×10^{-2}	0	7.0×10^{2}
Calvert Cliffs Units 1 and 2[(b)]									
2000	9.7×10^{1}	ND[(c)]	5.8×10^{-4}	ND	3.7×10^{1}	1.2×10^{-1}	2.7×10^{-1}	1.4×10^{-4}	1.1×10^{3}
2001	7.3×10^{1}	ND	1.2×10^{-3}	ND	2.0×10^{1}	6.3×10^{-2}	6.8×10^{-1}	4.7×10^{-5}	1.4×10^{3}
2002	**1.1×10^{2}**	**ND**	**2.7×10^{-3}**	**ND**	**2.4×10^{1}**	**1.9×10^{-1}**	**3.1×10^{-1}**	**ND**	**9.6×10^{2}**
2003	**1.6×10^{2}**	**ND**	**1.8×10^{-3}**	**ND**	**2.8×10^{1}**	**8.9×10^{-2}**	**6.7×10^{-2}**	**ND**	**8.1×10^{2}**
2004	1.6×10^{2}	ND	1.5×10^{-3}	2.7×10^{-4}	2.5×10^{1}	3.5×10^{-1}	2.8×10^{-2}	ND	1.5×10^{3}
Palo Verde Unit 2[(d)]									
2001	1.9×10^{2}	ND	7.2×10^{-4}	2.8×10^{-4}	6.3×10^{2}	None	None	None	None
2002	1.7×10^{2}	ND	9.7×10^{-3}	2.2×10^{-4}	2.7×10^{2}	None	None	None	None
2003	**9.2×10^{1}**	**ND**	**6.4×10^{-3}**	**7.3×10^{-4}**	**1.1×10^{3}**	**None**	**None**	**None**	**None**
2004	8.7×10^{-1}	ND	1.2×10^{-5}	3.3×10^{-10}	4.8×10^{2}	None	None	None	None
2005	4.6	ND	1.1×10^{-4}	5.6×10^{-5}	6.2×10^{2}	None	None	None	None

(a) Years in which steam generators were replaced are presented in bold text.
(b) Steam generator was replaced for Unit 1 in 2002 and for Unit 2 in 2003. The site reported releases from both units together.
(c) ND = Not detected.
(d) There were no liquid effluent releases beyond the site boundary.
Sources: Sites' annual effluent release reports

Table 4.9-3. Dose to the Maximally Exposed Individual (MEI) from Gaseous and Liquid Effluent Releases for Three Nuclear Power Plants That Recently Replaced Steam Generators

	Gaseous Effluents				Liquid Effluents	
Year[a]	**Total Body (mrem)**	**Gamma (mrad)**	**Beta (mrad)**	**Critical Organ (mrem)**	**Total Body (mrem)**	**Critical Organ (mrem)**
Arkansas Unit 2						
1999	2.3×10^{-2}	1.2×10^{-3}	3.8×10^{-3}	2.4×10^{-2}	1.7×10^{-3}	2.1×10^{-3}
2000	3.15×10^{-2}	2.70×10^{-3}	2.21×10^{-3}	3.15×10^{-2}	3.00×10^{-3}	3.90×10^{-3}
2001	1.5×10^{-2}	0	0	1.5×10^{-2}	1.0×10^{-3}	1.2×10^{-3}
2002	1.7×10^{-2}	0	1.0×10^{-4}	2.1×10^{-2}	1.6×10^{-3}	1.9×10^{-3}
2003	1.6×10^{-2}	0	1.0×10^{-4}	1.6×10^{-2}	1.3×10^{-3}	1.5×10^{-3}
Calvert Cliffs Units 1 and 2[b]						
2000	NR[c]	1.0×10^{-3}	7.0×10^{-3}	7.6×10^{-1}	3.0×10^{-1}	2.1×10^{-1}
2001	NR	1.0×10^{-3}	4.0×10^{-3}	3.5×10^{-2}	5.0×10^{-3}	4.3×10^{-1}
2002	**NR**	$\mathbf{1.0 \times 10^{-3}}$	$\mathbf{6.0 \times 10^{-3}}$	$\mathbf{1.7 \times 10^{-2}}$	$\mathbf{6.0 \times 10^{-3}}$	$\mathbf{2.0 \times 10^{-1}}$
2003	**NR**	$\mathbf{2.0 \times 10^{-3}}$	$\mathbf{1.0 \times 10^{-2}}$	$\mathbf{5.0 \times 10^{-2}}$	$\mathbf{2.0 \times 10^{-3}}$	$\mathbf{2.0 \times 10^{-2}}$
2004	NR	2.0×10^{-3}	8.0×10^{-3}	4.0×10^{-2}	2.0×10^{-3}	5.0×10^{-3}
Palo Verde Unit 2[d]						
2001	NR	1.6×10^{-2}	6.1×10^{-2}	2.4×10^{-1}	None	None
2002	NR	1.8×10^{-2}	5.3×10^{-2}	3.7×10^{-1}	None	None
2003	**NR**	$\mathbf{9.3 \times 10^{-3}}$	$\mathbf{3.1 \times 10^{-2}}$	$\mathbf{4.8 \times 10^{-1}}$	**None**	**None**
2004	NR	1.0×10^{-3}	5.0×10^{-4}	1.7×10^{-1}	None	None
2005	NR	2.9×10^{-3}	2.0×10^{-3}	2.2×10^{-1}	None	None

(a) Years in which steam generators were replaced are presented in bold text.
(b) Steam generator was replaced for Unit 1 in 2002 and for Unit 2 in 2003. The site reported doses from both units together.
(c) NR = Not reported in the site's effluent release report.
(d) There were no liquid effluent releases beyond the site boundary.
Sources: Sites' annual effluent release reports

some liquid effluents associated with decontamination, may be slightly greater than those found during the steam generator changeouts or recirculation piping replacements.

Continued Operations—During normal operations after license renewal, small quantities of radioactivity (fission, corrosion, and activation products) will continue to be released to the environment in a manner similar to that occurring during present operations (see Section 3.9.1).

The concentration of radioactive materials in soils and sediments increases in the environment at a rate that depends on the rate of release and the rate of removal. Removal can take place through radioactive decay or through chemical, biological, or physical processes. For a given rate of release, the concentrations of longer-lived radionuclides and, consequently, the dose rates attributable to them would continue to increase if license renewal was granted.

Regulatory Guide 1.109 (NRC 1977) provides guidance for calculating the dose for significant release pathways. To account for the buildup of radioactive materials, buildup factors are included in the calculations. Initially, most of the calculations for the construction and operating stage permits used 15 years as the approximate midpoint of a facility's operating life. This value is now more often taken to be 20 years. The potential license renewal term is an additional 20 years; thus, the effective midlife is 30 years.

The accumulation of radioactive materials in the environment is of concern not only with regard to license renewal but also with regard to operation under current licenses. NRC reporting rules require that pathways that may arise as a result of unique conditions at a specific site be considered in licensees' evaluations of radiation exposures. If an exposure pathway is likely to contribute significantly to total dose (10 percent or more to the total dose from all pathways), it must be routinely monitored and evaluated. Environmental monitoring programs are in place at all sites to provide a backup to the calculated doses based on effluent release measurements. Since these programs are ongoing for the duration of the license, locations where unique situations give rise to significant pathways that are not detailed in NRC Regulatory Guide 1.109 are to be identified if and when they become significant. If such pathways result in doses at a plant exceeding the design objectives of Appendix I to 10 CFR Part 50, action is required.

The radiation dose to the public from current operations results from gaseous effluent releases and from liquid effluent releases, as presented in Section 3.9.1.3. At present, for all operating nuclear plants, doses to the maximally exposed individual (MEI) are much less than the design objectives of Appendix I to 10 CFR Part 50 (Table 3.9-2). No aspect of future operation has been identified that would substantially alter this situation.

Maximum individual doses are reported in annual effluent release reports, and if these doses exceed Appendix I to 10 CFR Part 50 design objectives, the NRC would pursue remedial action. Thus these issues are handled on a case-by-case basis. Many plants have gone through license renewal, and no aging phenomenon that would increase public radiation doses has been identified. The operating reactors are not expected to reach regulatory dose limits more often in the period after license renewal than they do at present. For these reasons, dose impacts on MEIs in the public during future operation under license renewal are judged to be unchanged from those during present operations. The MEI dose ranges from 0.02 to 15.3 mrem/yr (see Table 3.9-16). At these dose levels, the increase in fatal cancer risk (using ICRP risk coefficients) to the MEI ranges from 1×10^{-8} to 7.7×10^{-6} for 1 year of reactor operations. Although dose rates (mrem/yr) are not expected to change during license renewal, the cumulative dose (total mrem) would increase as a result of 20 more years of operations. If the reactor operates for 60 years, it is estimated that the increase in fatal cancer risk to the MEI would range from 6×10^{-7} to 4.6×10^{-4} (a 50 percent increase over the baseline of 40 years of operation). However, it is unlikely that the same person would be exposed to these doses for 60 years of plant operations.

One of the pathways considered in calculating the MEI doses is direct radiation from operating plants. Radiation fields are produced around nuclear plants as a result of radioactivity within the reactor and its associated components, low-level storage containers, and components such as steam generators that have been removed from the reactor (as described in Section 3.9). Direct radiation from sources within a light water reactor (LWR) plant is due primarily to nitrogen-16, a radionuclide produced in the reactor core by neutron activation of oxygen-16 from the water. Because the primary coolant of an LWR is contained in a heavily shielded area, dose rates in the vicinity of LWRs are generally undetectable and less than 1 mrem/yr at the site boundary. Some plants (mostly BWRs) do not have completely shielded secondary systems and may contribute some measurable offsite dose. However, these sources of direct radiation will be unaffected by license renewal.

In addition to the regulations within 10 CFR 20.1101 that speak directly to required operation under ALARA principles, 10 CFR 50.36a imposes conditions on licensees in the form of technical specifications on effluents from nuclear power reactors. These specifications are intended to keep releases of radioactive materials to unrestricted areas during operations to ALARA levels. Appendix I to 10 CFR Part 50 provides numerical guidance on dose-design objectives and limiting conditions for the operation of LWRs to meet the ALARA requirements. These regulations will remain in effect during the period of license renewal (see Section 3.9.1.1).

To date, more than 70 operating reactors at over 40 nuclear power plant sites have gone through license renewal since 1996. In all cases, the radiation dose to members of the public from routine operations was within NRC regulations. This information was used to support the conclusion that the radiation dose to the public will continue at current levels associated with normal operations and are expected to remain much lower than the applicable standards.

Offsite doses to the public attributable to refurbishment activities were examined for the MEI. Because the focus of the analysis is on annual dose, only the results based on the most likely major refurbishment action were examined (i.e., replacing steam generators in PWRs and primary recirculation piping in BWRs). For this action, doses to the public were found to be SMALL. To date, effluents and doses during periods of major refurbishments have not been seen to differ significantly from those during normal operations. Consequently, gaseous effluents and liquid discharges occurring during major refurbishment actions are not expected to result in maximum individual doses exceeding the design objectives of Appendix I to 10 CFR Part 50 or the allowable EPA standards of 40 CFR Part 190 (Table 3.9-2).

Radiation doses to members of the public from the current operations of nuclear power plants have been examined from a variety of perspectives, and the impacts were found to be well within design objectives and regulations in each instance. No effect of aging that would significantly affect the radioactive effluents has been identified. Public doses are expected to remain well within design objectives and regulations. The cumulative cancer risk to the MEI would increase by 50 percent because the plant would operate for 20 more years, but the risk would still be small when compared with the cancer risk from background radiation.

Because there is no reason to expect effluents to increase in the period after license renewal, doses from continued operation are expected to be well within regulatory limits. No mitigation measures beyond those implemented during the current term license would be warranted, because current mitigation practices have kept public radiation doses well below regulatory standards and are expected to continue to do so.

Public radiological exposure impacts during license renewal and refurbishment were considered to be SMALL for all plants and were designated as Category 1 issues in the 1996 GEIS. No new information has been identified in the plant-specific SEISs prepared to date, the literature, or effluent and monitoring reports prepared by operating plants that would alter that conclusion. On the basis of these considerations, the NRC concludes that the impact of continued operations and refurbishment activities on public radiological exposure would be SMALL for all nuclear plants and remains a Category 1 issue.

4.9.1.1.2 Chemical Hazards

In nuclear power plants, chemical effects could result from discharges of chlorine or other biocides, small-volume discharges of sanitary and other liquid wastes, chemical spills, or heavy metals leached from cooling system piping and condenser tubing. Impacts of chemical discharges to human health are considered to be SMALL if the discharges of chemicals to water bodies are within effluent limitations designed to ensure protection of water quality, and if ongoing discharges have not resulted in adverse effects on aquatic biota. During the license renewal term, human health impacts from chemicals are expected to be the same as those experienced during operations in the original license term (see Section 3.9.2 for more details).

One environmental issue related to chemical hazards is reviewed here: human health impact from chemicals. This issue was not evaluated in the 1996 GEIS.

Human Health Impact from Chemicals

The types of chemical hazards that exist at a nuclear power plant are discussed in Section 3.9.2. Plant workers may encounter hazardous chemicals when the chemistries of the primary and secondary coolant systems are being adjusted, biocides are being applied to address the fouling of cooling system components, equipment containing hazardous oils or other chemicals is being repaired or replaced, solvents are being used for cleaning, or other equipment is being repaired. Exposures to hazardous chemicals are minimized when plant workers follow good industrial hygiene practices.

Reviews of the literature and operational monitoring reports and consultations with utilities and regulatory agencies that were done for the 1996 GEIS indicated that the effects of the discharge of chlorine and other biocides on water quality would be of SMALL significance for all plants. Small quantities of biocides are readily dissipated and/or chemically altered in the body of water receiving them, so significant cumulative impacts to water quality would not be expected. Major changes in the operation of the cooling system are not expected during the license renewal term, so no change in the effects of biocide discharges on the quality of the receiving water is anticipated. Major proposed changes in cooling system operations (e.g., those affecting the plant's licensing basis and possibly triggering a license amendment) would require a separate NEPA review including an examination of human health effects. In addition, proposed changes in the use of cooling water treatment chemicals would require review by the plant's NPDES permit-issuing authority and possible modification of the existing NPDES permit, including examination of the human health effects of the change. Effects of biocide discharges could be reduced by increasing the degree to which discharge water is treated, reducing the concentration of biocides, or treating only a portion of the plant cooling and service water systems at one time. Discharges of sanitary wastes are regulated by NPDES permit, and discharges that do not violate the permit limits are considered to be of SMALL significance.

The effects of minor chemical discharges and spills at nuclear plants on water quality have been of SMALL significance and mitigated as needed. Significant cumulative impacts on water quality would not be expected because the small amounts of chemicals released by these minor discharges or spills are readily dissipated in the receiving water body. Spills and off-specification discharges occur so seldom that regulatory agencies have not expressed any concern about them with regard to operating nuclear power plants. While there may be additional management practices or discharge-control devices that could further reduce the frequency of accidental spills and off-specification discharges, they are not warranted because impacts are already SMALL and occur at a low frequency.

Heavy metals (e.g., copper, zinc, and chromium) may be leached from condenser tubing and other heat exchangers and discharged by power plants as small-volume waste streams or corrosion products. Although all are found in small quantities in natural waters (and many are essential micronutrients), concentrations in the power plant discharge are controlled in the NPDES permit because excessive concentrations of heavy metals can be toxic to aquatic organisms.

Nuclear power plants may be required in some instances to submit annual reports on the environmental releases of listed toxic chemicals manufactured, processed, or otherwise used that are above identified threshold quantities depending on State regulations or other specific circumstances. The disposal of essentially all of the hazardous chemicals used at nuclear power plants is regulated by Resource Conservation and Recovery Act (RCRA) or NPDES permits. The NRC requires nuclear power plants to operate in compliance with all of its permits, thereby minimizing adverse impacts to the environment and on workers and the public. It is anticipated that all plants will continue to operate in compliance with all applicable permits, and no mitigation measures beyond those implemented during the current term license would be warranted as a result of license renewal.

On the basis of these considerations, the health impact from chemicals to workers and the public is considered SMALL for all nuclear plants. This is a Category 1 issue.

4.9.1.1.3 Microbiological Hazards

Some microorganisms associated with nuclear power plant cooling towers and thermal discharges can have deleterious impacts on the health of plant workers and the public. Certain microorganisms can benefit from thermal effluents. The potential for adverse health effects from microorganisms on nuclear power plant workers is an issue for plants that use cooling towers. Potential adverse health effects on the public from microorganisms in thermal effluents is an issue for nuclear plants that use cooling ponds, lakes, or canals, and that discharge to rivers. During the license renewal term, plant workers and members of the public would be exposed to microbiological hazards in the same way that they are exposed during operations in the original license term (see Section 3.9.3 for details).

Two environmental issues related to microbiological hazards are reviewed here:
(1) microbiological hazards to plant workers (issue was renamed from the 1996 GEIS) and
(2) microbiological hazards to the public (plants with cooling ponds or canals or cooling towers that discharge to a river) (issue was renamed and modified from the 1996 GEIS to include all rivers).

Microbiological Hazards to Plant Workers

The types of microbiological hazards that exist for nuclear power plant workers are discussed in Section 3.9.3. Pathogens of concern include *Salmonella* spp., *Shigella* spp., *Pseudomonas aeruginosa,* thermophilic fungi, *Legionella* spp., and *N. fowleri*. These species are all associated with nuclear plants that use cooling towers as part of their cooling water system. Because of the presence of these microorganisms, workers at nuclear power plants are typically required to use respiratory protection when cleaning cooling towers and condensers. Prairie Island Nuclear Generating Plant, which had high concentrations of *N. fowleri* in the circulating water, successfully controlled the pathogen and protected workers through chlorination before its yearly downtime operation (NRC 1980). The NRC has concluded that microorganisms that live in high-radiation and extreme heat conditions typical of the spent fuel pool do not pose a risk to plant workers (NRC 1999a).

No change in existing microbiological hazards is expected over the license renewal term. It is considered unlikely that any plants that have not already experienced occupational microbiological hazards would do so during the license renewal term or that hazards would increase over that period. It is anticipated that all plants will continue to employ proven industrial hygiene principles so that adverse occupational health effects associated with microorganisms will be of SMALL significance at all sites, and no mitigation measures beyond those implemented during the current term license would be warranted. Aside from continued application of accepted industrial hygiene procedures, no additional mitigation measures are expected to be warranted as a result of license renewal. This remains a Category 1 issue.

Microbiological Hazards to the Public (Plants with Cooling Ponds or Canals or Cooling Towers That Discharge to a River)

N. fowleri, which is the pathogenic strain of the free-living amoebae *Naegleria* spp., appears to be the most likely microorganism that may pose a public health hazard resulting from nuclear power plant operations. Increased populations of *N. fowleri* may have significant adverse impacts. On entry into the nasal passage of a susceptible individual, *N. fowleri* will penetrate the nasal mucosa. The ensuing infection results in a rapidly fatal form of encephalitis. Fortunately, humans in general are resistant to infection with *N. fowleri*. Hallenbeck and Brenniman (1989) have estimated individual annual risks for primary amebic meningoencephalitis caused by the free-living *N. fowleri* to swimmers in freshwater to be approximately 4×10^{-6}. Exposure to *Legionella* spp. from power plant operations would not generally impact the public because concentrated aerosols of the bacteria would not traverse plant boundaries. The information available on microorganisms that may inhabit high-radiation, high-temperature environments (such as the spent fuel pool) indicates that they are very unlikely to significantly increase in number in the environment and that they would not have a deleterious effect on public health (NRC 1999a).

From the studies presented in Section 3.9.3, it is clear that heavily used bodies of freshwater merit special attention and also possibly routine monitoring for pathogenic *Naegleria*. Since *Naegleria* concentrations in freshwater can be enhanced by thermal effluents, nuclear power plants that use cooling lakes, canals, ponds, or rivers experiencing low-flow conditions may enhance the populations of naturally-occurring thermophilic organisms. There are currently 23 reactor sites that fit this category. Data for 14 sites from this category that have gone through license renewal were reviewed to predict the level of thermophilic microbiological organism enhancement at any given site with current knowledge. For all 14 sites, no actual hazards to public health from enhancement of thermophilic microbiological organisms were identified, documented, or substantiated. However, without site-specific data, the same conclusion cannot be drawn for all reactor sites that would go through license renewal.

Changes in microbial populations and in the public use of water bodies might occur after the operating license is issued and the application for license renewal is filed. Other factors could also change, including the average temperature of the water, which could result from climate change that affected water levels and air temperature. Finally, the long-term presence of a power plant might change the natural dynamics of harmful microorganisms within a body of water. Therefore, the magnitude of the potential public health impacts associated with thermal enhancement of thermophilic organisms could be SMALL, MODERATE, or LARGE, depending on plant-specific conditions. This is considered a Category 2 issue.

4.9.1.1.4 Electromagnetic Fields

Nuclear power plants use power-transmission systems that consist of switching stations or substations located on the plant site and transmission lines located primarily offsite that connect the power plant to the regional electric grid. Electric fields and magnetic fields, collectively referred to as EMF, are produced by operating transmission lines. During the license renewal term, plant workers and members of the public who live, work, or pass near an associated operating transmission line may be exposed to the EMF in the same way that they are exposed during the current license term (see Section 3.9.4 for more detail). One environmental issue related to EMFs is reviewed in this section: chronic effects of electromagnetic fields (EMFs) (issue was renamed from the 1996 GEIS). The issue is further evaluated below by reviewing the relevant literature.

It should be noted that the scope of the evaluation of transmission lines in this revised GEIS is reduced from that of the 1996 GEIS. For this revision, only those transmission lines currently needed to connect the nuclear power plants to the regional electric distribution grid are considered within scope (see Sections 3.1.1 and 3.1.6.5 in this GEIS). Thus, the number and length of the transmission lines within the scope of license renewal environmental review are greatly reduced.

Ongoing Research on the Effect of Electromagnetic Fields

In 1990, the EPA's Office of Health and Environmental Assessment reviewed epidemiology studies, chronic lifetime animal tests, and laboratory studies of biological phenomena related to carcinogenesis. The review indicated that some epidemiological studies found an association between EMF and certain types of cancers, but others did not find any association. It was concluded that the scientific issues concerning the relationship between EMF and adverse health effects are very complex and difficult to interpret (EPA 1990). Without an understanding of how these EMF fields are interacting with biological functions, the knowledge gained from scientific studies was of limited value both in evaluating the importance of the study results and in devising protection strategies for the public and for utility workers.

A substantial body of evidence has been accumulated indicating that EMFs may influence biological function at exposure levels capable of producing relatively high current densities (10 to 100 mA/m^2) (IRPA/INIRC 1990). Such exposures have been suggested to induce chromosome aberrations, alter the distribution in molecular weights during protein synthesis, inhibit production of melatonin, alter calcium binding in brain tissue, influence ribonucleic acid (RNA) transcription, and produce a variety of other effects (OTA 1989). Questions concerning the potential carcinogenic effects of EMF field exposure have been raised as a result of suggestive epidemiological findings and some laboratory experiments. One accepted model on the development of cancer is the initiation-promotion paradigm (Easterly 1981). Most investigators conclude that EMFs are not likely to act as initiators because they have not been shown to cause genetic damage (Aldrich and Easterly 1987). EMF effects on RNA transcription, however, could imply increased reduction of oncogene products, and some investigators consider such data to be indicative of genetic effects (Goodman et al. 1987; Goodman and Henderson 1986, 1988). It has not been shown that EMF fields are cancer promoters, but the presence of some reported EMF biological effects reveals the need for further study of this issue (Byus et al. 1987).

Section 2118 of the Energy Policy Act of 1992 (Public Law 102-486, codified at 42 U.S.C. 13478) authorized the Electric and Magnetic Fields Research and Public Information Dissemination Program. The National Institute of Environmental Health Sciences (NIEHS), National Institutes of Health (NIH), and DOE were designated to direct and manage a program of research and analysis aimed at providing scientific evidence to clarify the potential for health risks from exposure to EMF (NIEHS 1999).

Over the course of this program, DOE and NIEHS managed more than 100 cellular and animal studies, exposure assessment studies, and engineering studies. No additional epidemiology studies were conducted; however, analyses of the studies that had already been conducted were an important part of the assessments (NIEHS 2002). In 1998, NIEHS completed the review of a comprehensive body of scientific research on the potential health effects of EMF.

NIEHS organized several technical symposia and a working group meeting to review EMF research. The working group was made up of scientists representing a wide range of disciplines (including engineering, epidemiology, cellular biology, medicine, toxicology, statistics, and pathology) brought together to review and evaluate the RAPID research and other research.

In June 1999, the NIEHS submitted the report, *NIEHS Report on Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields* (i.e., extremely low frequency electromagnetic fields [ELF-EMFs]) to Congress. In part, the report (NIEHS 1999) concluded the following:

> The scientific evidence suggesting that ELF-EMF exposures pose any health risk is weak. The strongest evidence for health effects comes from associations observed in human populations with two forms of cancer: childhood leukemia and chronic lymphocytic leukemia in occupationally exposed adults…. In contrast, the mechanistic studies and the animal toxicology literature fail to demonstrate any consistent pattern across studies and the animal toxicology literature fail to demonstrate any consistent pattern across studies although some sporadic findings of biological effects have been reported. No indication of increased leukemia in animals has been observed…. Virtually all of the laboratory evidence in animals and humans and most of the mechanistic work done in cells fail to support a causal relationship between ELF-EMF at environmental levels and changes in biological function or disease status. The lack of consistent, positive findings in animal or mechanistic studies weakens the belief that this association is actually due to ELF-EMF, but it cannot completely discount the epidemiological findings.

The NIEHS concluded that ELF-EMF exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. In the NIEHS opinion, this finding is insufficient to warrant aggressive regulatory concern. However, because virtually everyone in the United States uses electricity and is therefore routinely exposed to ELF-EMF, passive regulatory action is warranted, such as a continued emphasis on educating both the public and the regulatory community on ways in which to reduce exposure. NIEHS suggested that the power industry continue its current practice of siting power lines to reduce exposure and continue to explore ways to reduce the creation of magnetic fields around transmission and distribution lines without creating new hazards. NIEHS also encourages the use of technologies that lower exposures from neighborhood distribution lines, provided they do not increase other risks, such as those from accidental electrocution or fire. NIEHS does not believe that other cancers or noncancer outcomes provide sufficient evidence of a risk to warrant concern (NIEHS 1999).

In the United Kingdom, the National Radiological Protection Board (NRPB) established an independent Expert Advisory Group on Non-Ionizing Radiation (AGNIR) that reviewed scientific evidence relating possible adverse health effects to low-frequency EMFs (NRPB 2001, 2004). The earlier review (NRPB 2001) provided no firm evidence of a carcinogenic hazard to children or adults from exposure to normal levels of low-frequency EMFs, but made a number of recommendations for epidemiological studies and experimental work. The NRPB review in 2004 (NRPB 2004) concluded that currently, the results of these studies on EMF and health do not warrant quantitative restrictions on exposure to EMF. However, such studies, together with people's concerns, provide a basis for precautionary measures (NRPB 2004).

The World Health Organization (WHO) published an environmental health criteria monograph (WHO 2007) that addresses the possible health effects of ELF-EMF exposure. It reviewed the scientific literature on biological effects to assess the health risk from ELF-EMF exposure. It concluded the following about childhood leukemia:

> Scientific evidence suggesting that everyday, chronic low-intensity (above 0.3 to 0.4 μT) low-frequency magnetic field exposure poses a health risk is based on epidemiological studies demonstrating a consistent pattern of increased risk for childhood leukemia. Uncertainties in the hazard assessment include the role that control selection bias and exposure misclassification might have on the observed relationship between magnetic fields and childhood leukemia. In addition, virtually all of the laboratory evidence and the mechanistic evidence fail to support a relationship between low-level ELF magnetic fields and changes in biological function or disease status. Thus, on balance, the evidence is not strong enough to be considered causal, but sufficiently strong to remain a concern.

The potential for transmission line EMF to cause adverse health impacts in humans has been reviewed by many scientific groups. The hazard is assessed by a standard scientific approach that considers data from epidemiologic, laboratory, and biophysical studies. A number of epidemiologic studies have reported a small degree of association between measures of EMF and several diseases such as childhood leukemia. Other studies have failed to find an association. A causal basis for the EMF associations is not supported by laboratory and biophysical evidence, and the actual basis remains unexplained. Nonetheless, in 2002, the International Agency for Research on Cancer (IARC 2002) designated EMF as a class 2B carcinogen ("possibly carcinogenic"), on the basis of "consistent statistical associations of high-level residential magnetic fields with a doubling of the risk of childhood leukemia." The WHO (2007) monograph did not change the EMF classification on the basis of new human, animal, and in vitro studies published since the IARC (2002). In 2002, the California Department of Health Services issued a report (CADHS 2002) concluding that "EMFs can cause some degree of increased risk of childhood leukemia, adult brain cancer, Lou Gehrig's disease, and miscarriage." Kheifets et al. (2005) assessed the potential susceptibility of children to EMFs and recommended additional research and the development of precautionary policies.

The WHO (2007) monograph also reviewed literature that looked at a number of other diseases such as cancers in children and adults, depression, suicide, reproductive dysfunction, developmental disorders, immunological modifications, and neurological disease. On the basis of this review, it concluded the following:

> The scientific evidence supporting a linkage between ELF magnetic fields and any of these diseases is much weaker than for childhood leukemia and in some cases (for example, for cardiovascular disease or breast cancer) the evidence is sufficient to give confidence that magnetic fields do not cause the disease.

Extensive investigations of animals exposed at much higher levels of magnetic fields (up to 5 mT) have not demonstrated adverse health effects (Boorman et al. 2000). The elevated levels of EMF exposure in occupational settings likewise do not show a consistent pattern of increased risk for acute myocardial infarction or chronic coronary heart disease (Sahl et al. 2002). Laboratory studies of cells and tissues do not support the hypothesis that EMF exposure at ambient levels is a significant risk factor for human disease (NIEHS 1999). The failure to observe biological effects from EMF exposure may be due to the fact that, mechanistically, effects of EMF on biology are very weak (Valberg et al. 1997) or the association between the epidemiological results on childhood leukemia and EMF be the result of chance or a confounding factor (Draper et al. 2005).

Chronic Effects of Electromagnetic Fields (EMFs)

An important question regarding regulations is whether transmission line exposures contribute significantly to total EMF exposures. In most cases, fields produced inside the home by appliances and electrical wiring are greater than the contributions from transmission line fields. Exceptions to this rule are individuals living next to a high-voltage transmission line ROW. Also relevant is the fact that exposures to transmission line fields are considered more continuous than those to appliance fields because transmission line fields permeate large areas (e.g., an entire home). Fields generated by appliances are generally more localized, resulting in intermittent exposures as individuals move around and as the appliances are turned on and off.

The earth's atmosphere produces slowly varying electric fields that average less than a few hundred V/m, and the earth's core produces a steady magnetic field in a range from about 0.3 to 0.6 G. Near appliances, the magnetic fields can be high, but they diminish sharply with distance. Table 4.9-4 shows the magnetic fields at different distances from household appliances (HCCP 2007). Typical house wiring and appliances contribute a 60-Hz magnetic field that can be up to about 3 mG (not in the vicinity of appliances). Some comparisons

Table 4.9-4. Magnetic Fields at Different Distances from Household Appliances

Household Appliance	Magnetic Fields (mG) at Different Distances		
	3 cm	30 cm	100 cm
Microwave oven	750–2,000	40–80	3–8
Fluorescent lamp	400–4,000	5–20	0.1–3
Electric cooking stove	60–2,000	4–40	0.1–1
Television	25–500	0.4–20	0.1–2
Clothes washer	8–400	2–30	0.1–2

Source: HCCP 2007

(of induced currents) among transmission line exposures, domestic exposures, and exposures used in biological effects experiments can be made by using induced current density as an exposure metric. According to data provided in OTA (1989), field strengths on the ROW of a 500-kV line induce body currents that are higher than those induced by domestic exposures produced by typical electrical appliances. A comparison with the results of biological effects experiments (OTA 1989) shows that while current densities in many biological effects experiments are higher than those typically induced by household exposures, some current densities are significantly lower. These comparisons are based, however, on average current densities predicted in humans, because EMF dosimetry has not advanced to the point of determining specific current densities in various tissues and organs. Moreover, researchers have not identified what field characteristics are important biologically.

Conclusion on Electromagnetic Fields

A review of the biological and physical studies of 60-Hz EMFs did not find any consistent evidence that would link harmful effects with field exposures. EMFs are unlike other agents that have a toxic effect (e.g., toxic chemicals and ionizing radiation) in that dramatic acute effects cannot be forced, and longer-term effects, if real, are subtle. Nonetheless, a wide range of biological responses have been reported to be affected by EMFs.

Even if clear adverse effects were apparent in the epidemiology literature or with some biological assay, considerable additional work would be required to determine how and what to mitigate, because evidence suggests that some EMF biological effects do not follow the typical “more intensity is worse” relationship. Furthermore, there may be a subtle relationship between the intensity of the local geomagnetic field and the appearance of effects for some intensities of 60-Hz fields. This complicating evidence points to the fact that, while much experimental and epidemiological evidence has been accrued, the pieces still do not fit together very well.

Because of inconclusive scientific evidence, the chronic health effects of EMF are considered uncertain, and currently, no generic impact level can be assigned. The NRC will continue to monitor the research initiatives—both those within the national EMF program and others internationally—to evaluate the potential carcinogenicity of EMFs as well as other progress in the EMF study disciplines. If the NRC finds that the appropriate Federal health agencies have reached a consensus on the potential human health effects from exposure to EMF, the NRC will revise the GEIS to include the new information and determine what to require of all future license renewal applicants.

4.9.1.1.5 Other Hazards

Two additional human health issues are addressed in this section: (1) physical occupational hazards (new issue not considered in the 1996 GEIS) and (2) electric shock hazards (issue was renamed from the 1996 GEIS).

Nuclear power plants are industrial facilities that have many of the typical occupational hazards found at any other electric power generation utility. Workers at or around nuclear power plants would be involved in some electrical work, electric power line maintenance, repair work, and maintenance activities and exposed to some potentially hazardous physical conditions (e.g., excessive heat, cold, and pressure). The issue of physical occupational hazards is generic to all nuclear power plants.

Transmission lines are needed to transfer energy from the nuclear power plant to consumers. The workers and general public at or around the nuclear power plants and along the transmission lines are exposed to the potential for acute electrical shock from these lines. The issue of electrical shock is generic to all nuclear power plants. As described in Sections 3.1.1 and 3.1.6.5, in-scope transmission lines include only those lines that would not continue to operate if a plant's license was not renewed. Using this criterion, in-scope transmission lines are those lines that connect the plant to the first substation of the regional electric grid. This substation is frequently, but not always, located on the plant property.

During the license renewal term, human health impacts from physical occupational hazards and acute shock hazards would be the same as those from operations during the original license term (see Section 3.9.5 for more detail).

<u>Physical Occupational Hazards</u>

The types of occupational hazards that exist at a nuclear power plant are discussed in Section 3.9.5. The issue of occupational hazards is evaluated by comparing the rate of fatal injuries and nonfatal occupational injuries and illnesses in the utility sector with the rate in all industries combined. Occupational hazards can be minimized when workers adhere to safety standards and use appropriate personal protective equipment; however, fatalities and injuries from accidents can still occur. Data for occupational injuries from the U.S. Bureau of Labor Statistics (BLS) for 2005 (BLS 2005a,b,c) indicate that the rate of fatal injuries in the utility sector is less than the rate for many sectors (construction; transportation and warehousing; agriculture, forestry, fishing, and hunting; wholesale trade; and mining) and that the incidence rate for nonfatal occupational injuries and illnesses is the least for electric power generation, followed by electric power transmission control and distribution (see Section 3.9.5). The fatality rate for electric power line installers and repairers can be estimated at 0.032 percent (BLS 2005a). It is expected that over the license renewal term, workers would continue to adhere to safety standards and use protective equipment, so adverse occupational impacts would be of SMALL significance at all sites, and no mitigation measures beyond those implemented during the current license term would be warranted. The impact of these hazards is a Category 1 issue.

Electric Shock Hazards

The greatest hazard from a transmission line is direct contact with the conductors. Tower designs preclude direct public access to the conductors. However, electrical contact can be made without physical contact between a grounded object and the conductor. Secondary shock currents are produced when humans make contact with (1) capacitively charged bodies, such as a vehicle parked near a transmission line, or (2) magnetically linked metallic structures, such as fences near transmission lines. A person who contacts such an object could receive a shock and experience a painful sensation at the point of contact. The intensity of the shock would depend on the EMF strength, size of the object, and how well the object and person were insulated from ground.

Design criteria for nuclear power plants that limit hazards from steady-state currents are based on the National Electrical Safety Code (NESC), adherence to which requires that utility companies design transmission lines so that the short-circuit current to ground produced from the largest anticipated vehicle or object is limited to less than 5 mA (IEEE 2007). With respect to shock safety issues and license renewal, three points must be made. First, in the licensing process for the earlier licensed nuclear plants, the issue of electrical shock safety was not addressed. Second, some plants that received operating licenses with a stated transmission line voltage may have chosen to upgrade the line voltage for reasons of efficiency, possibly without reanalysis of induction effects. Third, since the initial NEPA review for those utilities that evaluated potential shock situations under the provision of the NESC, land use may have changed, resulting in the need for a reevaluation of this issue. The electrical shock issue, which is generic to all types of electrical generating stations, including nuclear plants, is of SMALL significance for transmission lines that are operated in adherence with the NESC. Without a review of the conformance of each nuclear plant's transmission lines, within this scope of review, with NESC criteria, it is not possible to determine the significance of the electrical shock potential generically; it could be SMALL, MODERATE, or LARGE. The impact of this hazard remains a Category 2 issue.

4.9.1.2 Environmental Consequences of Postulated Accidents

Design-Basis Accidents and Severe Accidents

Chapter 5 of the 1996 GEIS assessed the impacts of postulated accidents at nuclear power plants (NPPs) on the environment. The postulated accidents included design-basis accidents and severe accidents (e.g., those with core damage). The impacts considered included:

- Dose and health effects of accidents (5.3.3.2 through 5.3.3.4);
- Economic impacts of accidents (5.3.3.5); and
- Impact of uncertainties on results (5.3.4).

The estimated impacts were based upon the analysis of severe accidents at 28 NPPs,[c] as reported in the environmental impact statements (EISs) and/or final environmental statements (FESs) prepared for each of the 28 plants in support of their operating licenses. With few exceptions, the severe accident analyses were limited to consideration of reactor accidents caused by internal events. The 1996 GEIS addressed the impacts from external events qualitatively. The severe accident analysis for the 28 plants was extended to the remainder of plants whose EISs did not consider severe accidents (since such analysis was not required at the time the other plants' EISs were prepared). The estimates of environmental impact contained in the 1996 GEIS used 95th percentile upper confidence bound (UCB) estimates whenever available. This provides conservatism to cover uncertainties, as described in Section 5.3.3.2.2 of the 1996 GEIS. The 1996 GEIS concluded that the probability-weighted consequences and impacts were SMALL compared to other risks to which the populations surrounding NPPs are routinely exposed.

Appendix E of this document provides an update on postulated accident risk. Since the NRC's understanding of accident risk has evolved since the issuance of the 1996 GEIS, Appendix E assesses more recent information on postulated accidents that might have had the potential to alter the conclusions in Chapter 5 of the 1996 GEIS. This update considers how these

(c) The 28 sites are listed in Table 5.1 of the 1996 GEIS. There are a total of 44 units included in this list, but 4 of these units never operated (Grand Gulf 2, Harris 2, Perry 2, and Seabrook 2). For the purpose of this document, this list will be referred to as containing 28 NPPs, but when mean values are calculated for this subset of NPPs, the 40 units that operated are considered.

developments would affect the conclusions in the original GEIS and provides comparative data where appropriate.

The different sources of new information can be generally categorized by their effect of either decreasing, not affecting, or increasing the best-estimate environmental impacts associated with postulated severe accidents. Those areas where a decrease in best-estimate impacts would be expected are:

- New internal events information (decreases by an order of magnitude), and
- New source term information (significant decreases).

Areas likely leading to either a small change or no change include:

- Use of BEIR-VII risk coefficients.

Lastly, those areas leading to an increase in best-estimate impacts would consist of:

- Consideration of external events (comparable to internal event impacts),
- Power uprates (small to moderate increase),
- Higher fuel burnup (small to moderate increases),
- Low power and reactor shutdown events (could be comparable to full-power event impacts), and
- Spent fuel pool accidents (could be comparable to full-power event impacts).

Given the difficulty in conducting a rigorous aggregation of these results with the differences in the information sources utilized, a fairly simple approach is taken. The latter group contains three areas where the increase could be comparable to the current risk and two areas where the increase could approach 30–40 percent. The net increase from these five areas would therefore be (in a simplistic sense) approximately 470 percent[d] (increase by a factor of 4.7). The reduction in risk due to newer internal event information would account for a decrease by a factor of 5 to 100. The net effect of an increase on the order of 500 percent and a decrease on the order of 500 percent to 10,000 percent would be lower estimated impacts (as compared to the 1996 GEIS assessment).

(d) This approximation simply assumes that each comparable area results in an increase of 100 percent and the other two areas (uprates and burnup) each result in an increase of 35 percent.

Furthermore, even if one assumed that the net effect of the new information was no change in risk, the information provided throughout Appendix E demonstrates that the level of conservatism in the upper bound estimates utilized in the 1996 GEIS is much larger than the individual (or cumulative) deltas from the updated information. In particular, Section E.3.1 of Appendix E demonstrates that the 1996 GEIS values were a factor of 2 to 4 higher than the underlying EIS values.

With respect to uncertainties, the 1996 GEIS contained an assessment of uncertainties in the information used to estimate the environmental impacts. Section 5.3.5 of the 1996 GEIS discusses the uncertainties and concludes that they could cause the impacts to vary anywhere from a factor of 10 to a factor of 1,000. This range of uncertainties bounds the uncertainties discussed in Section E.3.9 of Appendix E of this document, which ranged from a factor of 3 to 10, as well as the uncertainties brought in by the other sources of new information.

Given the discussion in Appendix E of this document, the staff concludes that the reduction in environmental impacts from the use of new information (since the 1996 GEIS analysis) outweighs any increases resulting from this same information. As a result, the findings in the 1996 GEIS remain valid. Therefore, design-basis accidents remain a Category 1 issue, and although the probability-weighted consequences of severe accidents are SMALL for all plants, severe accidents remain a Category 2 issue to the extent that only alternatives to mitigate severe accidents must be considered for all plants that have not previously considered such alternatives.

In addition, it is reasonable based on the discussion in Appendix E that, in license renewal applications, the impacts from reactor accidents at full power (including internal and external events) should continue to be considered in assessing severe accident mitigation alternatives (SAMAs). The impacts of all other new information do not contribute sufficiently to the environmental impacts to warrant their inclusion in the SAMA analysis since the likelihood of finding cost-effective plant improvements is small. Alternatives to mitigate severe accidents still must be considered for all plants that have not considered such alternatives; however, as discussed further in Appendix E, those plants that have already had a SAMA analysis considered by the NRC as part of an EIS, supplement to an EIS, or EA, need not perform an additional SAMA analysis for license renewal. Table 4.9-5 provides a summary of the conclusions discussed above.

Table 4.9-5. Summary of Issues Covered in Appendix E

Topic (Section)	Conclusions
New Internal Events Information (Section E.3.1)	New information on the risk and environmental impacts of severe accidents caused by internal events indicates that PWR and BWR core damage frequencies (CDFs) are generally comparable to or less than those forming the basis of the 1996 GEIS. In some cases, these differences are significant (approaching 1 order of magnitude). Comparison of population dose from newer assessments illustrates a reduction in impact by a factor of 5 to 100 when compared to older assessments, and an additional factor of 2 to 4 due to the conservatism built into the 1996 GEIS values. This would also mean that contamination of open bodies of water and economic impacts would, in most cases, be significantly less. Additionally, the likelihood of basemat melt-through accidents is less than that used in the analysis supporting the 1996 GEIS.
Consideration of External Events (Section E.3.2)	The 1996 GEIS did not quantitatively consider severe accidents initiated by external events in assessing environmental impacts. When the environmental impacts of external events are considered, they can be comparable to those from internal events; however, they are generally lower than the estimates used in the 1996 GEIS for internal events. This conclusion would also apply to the contamination of open bodies of water, groundwater and economic impacts.
New Source Term Information (Section E.3.3)	More recent source term information indicates that the timing from dominant severe accident sequences, as quantified in NUREG/CR-6295, is comparable to the analysis forming the basis of the 1996 GEIS. In most cases, the release frequencies and release fractions are significantly lower for the more recent estimate. Thus, the environmental impacts used as the basis for the 1996 GEIS are higher than the impacts that would be estimated using the more recent source term information.
Power Uprates (Section E.3.4)	Based on a comparison of the change in large early release frequency (LERF) for extended power uprates, a small to moderate increase in environmental impacts results from the increase in operating power level.
Higher Fuel Burnup (Section E.3.5)	Increased peak fuel burn-up from 42 to 75 GWd/MT for PWRs and 60 to 75 GWd/MT for BWRs is estimated to result in small to moderate increases in the environmental impacts in the event of a severe accident.
Consideration of Low Power and Reactor Shutdown Events (Section E.3.6)	The environmental impacts from accidents at low power and reactor shutdown conditions are generally comparable to those from accidents at full power when comparing the values in NUREG/CR-6143 and NUREG/CR-6144 to those in NUREG-1150. Even so, the 1996 GEIS estimates of the environmental impact of severe accidents bound the potential impacts from accidents at low power and reactor shutdown. Finally, as cited above and discussed in SECY-97-168, industry initiatives taken during the early 1990s have also contributed to the improved safety of low power and reactor shutdown operation.
Consideration of Spent Fuel Pool Accidents (Section E.3.7)	The environmental impacts from accidents at spent fuel pools (SFPs) (as quantified in NUREG-1738) can be comparable to those from reactor accidents at full power (as estimated in NUREG-1150). Subsequent analyses performed and mitigative measures employed since 2001 have further lowered the risk of this class of accidents. In addition, the conservative estimates from NUREG-1738 are much less than the impacts from full-power reactor accidents that are estimated in the 1996 GEIS.

Table 4.9-5. (cont.)

Topic (Section)	Conclusions
Use of BEIR-VII Risk Coefficient (Section E.3.8)	Use of newer risk coefficients such as in BEIR VII is expected to have a small impact on the results presented in the 1996 GEIS.
Uncertainties (Section E.3.9)	The impact and magnitude of uncertainties, as estimated in the 1996 GEIS, bound the uncertainties introduced by the new information and considerations.
SAMAs (Section E.4)	The current process and scope of SAMA analysis is sufficient for determining the need for additional mitigative measures.
Summary/Conclusion (Section E.5)	Given the new and updated information, the reduction in estimated environmental impacts from the use of new internal event and source term information outweighs any increases from the consideration of external events, power uprates, higher fuel burnup, low power and reactor shutdown risk, and SFP risk.

4.9.2 Environmental Consequences of Alternatives to the Proposed Action

Construction—Impacts on workers are expected to be similar to those experienced during construction of any major industrial facility. Impacts from construction of combustion-based renewable energy facilities are expected to be the same as those for construction of fossil fuel facilities. Construction would increase traffic on local roads, which could affect the health of the general public. Human health impacts would be the same for all facilities whether located on greenfield sites, brownfield sites, or at an existing nuclear plant. Personal protective equipment, training, and engineered barriers would protect the workforce.

Summaries of statistics maintained by the U.S. Department of Labor, Bureau of Labor Statistics (Meyer and Pegula 2006) indicate that construction activities are responsible for a significant share of workplace accidents. In 2004, the construction industry accounted for 1 in 5 fatal workplace injuries and 1 in 10 nonfatal workplace injuries. With a workforce of 10,272,000 workers in 2004, the private construction industry registered 1,234 total fatalities in the following categories: falls, 445 (36 percent); transportation incidents, 287 (23 percent) (highway 148, non-highway 45, worker struck by vehicle/mobile equipment, 78); contact with objects and equipment, 267 (18 percent) (struck by object, 150; caught in or crushed in collapsing materials 71); exposure to harmful substances and environments, 170 (14 percent); and contact with electric current, 122 (10 percent). Over that same period, of a total of 401,000 nonfatal injuries and illnesses in the construction industry (nonfatal injuries that resulted in at least one day away from work) totaled 153,200 in the following categories: overexertion, 30,460 (20 percent); struck by object, 27,950 (18 percent); fall to lower level, 20,950 (14 percent); fall to same level, 12,700 (8 percent); and struck against object, 12,720 (8 percent).

4.9.2.1 Fossil Energy Alternatives

Environmental Consequences of Normal Operating Conditions

Operations—In 2006, the U.S. Department of Labor's (DOL's) Bureau of Labor Statistics revealed 134,400 individuals employed in the fossil fuel electric power generation industrial sector (North American Industry Classification System (NAICS) Code 221112) (DOL 2007a). For 2006 (DOL 2007b), DOL documented 17 total fatalities for all of the electric power generating industrial sector (NAICS Code 22111) and 5 fatalities for fossil fuel electric power generation. In 2006, the nonfatal injury and illness incident rate was 3.9 cases per 100 fulltime workers, slightly higher than the incident rate of 3.1 cases per 100 full-time workers for the entire electric power generation sector. Total reportable incidents occurred at a rate of 2.2 per 100 full-time workers. Those incidents that resulted from lost time at work occurred at a rate of 1.2 cases per 100 full-time workers.

Human health risks are associated with the management and disposal of coal combustion waste. Human health risks may extend beyond the facility workforce to the public and are proximate to the coal combustion waste disposal facility. The character and the constituents of coal combustion waste depend on both the chemical composition of the source coal and the technology used to combust it. Generally, the primary sources of adverse consequences from coal combustion waste are the presence of leachable, toxic (and, in some cases, carcinogenic) heavy metals primarily contained in fly ash and bottom ash, especially arsenic, selenium, and mercury. With future implementation of regulations limiting mercury emissions, the amount of mercury present in coal combustion waste is expected to rise, and, depending on the particular chemical speciation, the amount of leachable mercury in coal combustion waste may also increase. Depending on the coal source, radionuclides may also be present in coal combustion waste.

The EPA is considering regulations specific to disposal of coal combustion waste under the authority of Subtitle D of RCRA (EPA 2007). Preliminary (draft) risk assessments of historical disposal practices for coal combustion waste in landfills and surface water impoundments identified both direct and indirect (food chain contamination) pathways for human exposure. Overall, when all types of landfills and surface impoundments are evaluated in aggregate, the cancer risk criterion for arsenic (1×10^{-6}) can be exceeded for both unlined units (5×10^{-4}) and clay-lined units (2×10^{-4}). Arsenic cancer risks are higher for unlined surface impoundments (9×10^{-3}) and for clay-lined units (3×10^{-3}). Composite (synthetic) liners, which have been used in the majority of the most recently constructed landfills and surface impoundments, greatly reduce infiltration of leachable constituents, so much so that risks at all percentiles fall below both the cancer and noncancer risk criteria for both landfills and surface impoundments.

Although future alternative power generating facilities are most likely to use offsite disposal of coal combustion waste, some short-term storage of coal combustion waste (either in open piles or in surface impoundments) is likely to take place onsite, thus establishing the potential for leaching of toxic constituents into the local environment. Mobility studies indicate that toxic constituents take hundreds to thousands of years to leach through the bottoms of landfills and less than 100 years to leach through the bottom surface impoundments. However, because each batch of coal combustion waste would likely remain in interim onsite storage for only a short period, the potential for release of toxic constituents into the environment is greatly reduced. Offsite disposal facilities would be designed and operated in a manner that minimizes impacts from leached constituents.

Environmental Consequences of Accidents

Operations—Accidents involving fossil fuel energy sources that affect the functionality of the boiler or the steam cycle would have the most significant impacts. Steam explosions and other mechanical failures have the potential for adverse consequences on the workforce, but are not likely to directly affect the surrounding public or natural resources. Failures of pollution control devices would have an immediate but short-term impact on the environment because of the resulting release of pollutants. However, operating permits would require immediate shutdown of combustion sources whose pollution control devices became inoperative and prohibit continued operation that bypasses the failed control device. However, pollution control device failures, as well as other accidents that are sufficiently severe so as to require the shutdown of operations, would result in indirect impacts on the public in the form of reduced available power and possible short-term brownouts or blackouts. Although power might be restored relatively quickly, longer-term impacts may include a temporary rise in the levelized cost of electricity.

Overall, impacts on the environment from accidents at a fossil-fuel fired plant are expected to be short-lived and small. Longer-term impacts on socioeconomics could be anticipated both as a result of job loss and (temporary) higher costs of energy, but overall would be expected to be SMALL.

4.9.2.2 New Nuclear Alternatives

Environmental Consequences of Normal Operating Conditions

Operations—Operational human health impacts for a new nuclear plant would include radiation exposure to the public (at very low levels) and to the operational workforce; impacts from exposure to microbiological organisms; occupational safety risks; impacts from electromagnetic fields; and exposure to chemicals used onsite by the workers. Impacts on human health, in most cases, were determined to be SMALL in 10 CFR Part 51, Appendix B, Table B-1, and although the table is specific to license renewal, similar human health impacts would be expected from the operation of a new nuclear facility. Human health impacts would be the same for all facilities, whether located on greenfield sites, brownfield sites, or sites located at a previously existing nuclear plant, and are expected to be SMALL.

Environmental Consequences of Accidents

A detailed analysis of postulated accidents in currently operating reactors (affected by license renewal) is provided in Section 4.9.1.2. Although the analysis is specific to license renewal, the impacts are representative of the impacts expected for new reactors. New reactor designs incorporate additional safety features not found in currently operating reactors. As a result, it is expected that the risks associated with the new reactors would be comparable to or less than the risks associated with currently operating reactors. Before a license is granted, the application for a new reactor would undergo a detailed safety and environmental review to ensure that the plant, if constructed, would operate in accordance with all applicable NRC rules and regulations.

4.9.2.3 Renewable Alternatives

Operations—The operational impacts of alternative energy technologies on human health are presented in the following subsections.

Hydroelectric Energy Sources

Impacts on workers include working near energized systems and high pressure water.

Geothermal

Operating workers could be affected by exposure to toxic gases and other constituents present in geothermal fluids, energized systems, including high pressure and high temperature gases and fluids, and electromagnetic fields associated with the generation, conditioning, and transmission of electricity. Workers could be affected by exposure to toxic constituents, including boron, arsenic, radon, and mercury.

Wind

Operational hazards for the workforce include working at heights, near rotating mechanical or energized equipment, and working in extreme weather. Additional hazards unique to offshore wind farms include navigating and working in heavy seas. Potential impacts to workers and the public include ice thrown from rotor blades and blades thrown from mechanical failure and disintegration. Potential impacts also include EMF exposure, aviation safety, electromagnetic interference, and exposure to low-frequency sound.

Biomass

Human health risks to workers are expected to be similar to workers in a coal combustion facility. Work hazards include exposure to heat, gases, chemicals, high temperature liquids, and energized mechanical and electrical equipment. The potential exists for exposure to inhalable particulates and polycyclic aromatic hydrocarbons (PAHs) resulting from incomplete combustion of complex organic molecules. The public could be affected by fugitive dust and contaminated water.

Municipal Solid Waste, Refuse-Derived Fuel, and Landfill Gas

Combustion of municipal solid waste and/or refuse-derived fuel may result in the release of constituents that are persistent, bioaccumulative, and toxic, PAHs, and chlorinated hydrocarbons. The workforce as well as nearby residents could be affected by the release of toxic constituents to the air. The workforce could also be affected by exposure to toxic wastes.

Solar Thermal

Potential hazards to workforce include exposure to extremely hot heat transfer fluids or burned from misaligned mirrors and contact with energized system components.

Solar Photovoltaic

Workers could be exposed to airborne toxic heavy metals (e.g., cadmium) and silicon if the photovoltaic cell loses integrity from a fire. Workers could also inhale silicon dust if the integrity of photovoltaic cells was compromised by an accident.

Ocean Wave and Current

Operation of wave- and current-energy capturing systems would not be expected to affect human health. Workers could be affected by possible exposure to energized systems, inclement weather conditions, and high sea states. Workers could be affected by work underwater inspecting and repairing cables and tethers.

4.10 Environmental Justice

4.10.1 Environmental Consequences of the Proposed Action—Continued Operations and Refurbishment Activities

Impacts of nuclear plant operations and refurbishment on minority and low-income populations living in the vicinity of nuclear power plants were not addressed in the 1996 GEIS because guidance for implementing Executive Order 12898 was not available at the time. Environmental justice was listed in Table B-1 in Appendix B, Subpart A, of 10 CFR Part 51, but was not assigned an issue category or impact significance. The finding in Table B-1 stated that “the need for and the content of an analysis of environmental justice will be addressed in plant-specific reviews.” Therefore, impacts to “minority and low-income populations,” was evaluated as a new issue for this GEIS revision.

The NRC addresses environmental justice matters for license renewal through (1) identifying the location of minority and low-income populations that the continued operation of the nuclear power plant may affect during the license renewal term, (2) determining whether there would be any potential human health or environmental effects to these populations and special pathway receptors, and (3) determining if any of the effects may be disproportionately high and adverse.

Minority and Low-Income Populations

The environmental justice impact analysis considers the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from continued nuclear plant operations and refurbishment activities at a nuclear power plant. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionately high environmental effects refer to impacts or risk of impact on the natural or physical environment in a minority or low-income community that are significant and appreciably exceed the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts. Some of these potential effects have been identified in resource areas discussed in this section. For example, increased demand for rental housing during replacement power plant construction could disproportionately affect low-income populations. Minority and low-income populations are subsets of the general public residing around the site, and all are exposed to the same risks and hazards generated from operating a nuclear power plant.

Continued reactor operations and other activities associated with license renewal could have an impact on air, land, water, and ecological resources in the region around each nuclear power plant site, which might, create human health and environmental effects on the general population. Depending on the proximity of minority and low-income populations in relation to each nuclear plant, the environmental impacts of license renewal could have a disproportionate effect on these populations.

There is considerable variation in the representation of minority and low-income populations within 50 mi (80 km) of each nuclear power plant site. Sites located in the southern and southwestern United States have large minority populations (e.g., Browns Ferry, Brunswick, Catawba, Farley, North Anna, Robinson, Summer, and Surry plants). Sites located close to metropolitan areas also have larger minority populations as well as larger low-income populations (e.g., Dresden, Ginna, Indian Point, and Pilgrim plants).

The location and significance of environmental impacts may affect population groups that are particularly sensitive because of their resource dependencies or practices (e.g., subsistence agriculture, hunting, or fishing) that reflect the traditional or cultural practices of minority and low-income populations. The analysis of special pathway receptors can be an important part of the identification of resource dependencies or practices. Special pathways take into account the levels of contaminants in native vegetation, crops, soils and sediments, surface water, fish, and game animals on or near the power plant sites in order to assess the risk of radiological exposure through subsistence consumption of fish, native vegetation, surface water, sediment, and local produce; the absorption of contaminants in sediments through the skin; and the inhalation of airborne particulates. All licensed nuclear plants have a comprehensive radiological environmental monitoring program to assess the impact of site operations on the environment. Samples are collected from the aquatic and terrestrial pathways applicable to these sites. Aquatic pathways include fish, surface water, and sediment; terrestrial pathways include airborne particulates, radioiodine, milk, food products, crops, and direct radiation. Concentrations of contaminants in native vegetation, crops, soil, sediment, surface water, fish, and game animals in areas surrounding nuclear power plants have generally been found to be quite low (at or near the threshold of detection) and seldom above background levels.

Pathways associated with continued operations and other activities at nuclear plants associated with the license renewal might affect human populations were considered. Also considered was the extent to which minority and low-income populations in the area around these plants could be disproportionately affected, through resource dependencies and practices (e.g., subsistence agriculture, hunting, or fishing). In addition, plant-specific impacts that could affect minority and low-income populations were also identified at nuclear power plants. Although the overall impact of nuclear plants on the general population has usually been found to be small, because of these unique considerations, the additional examination of the nature and geographic extent of impacts and population demographics should be considered on a plant-specific basis.

While not binding upon independent regulatory agencies such as the NRC, Executive Order 12898 requires certain specified Federal agencies to identify and address, as appropriate, “disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.” The NRC’s “Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions” (69 FR 52040, August 24, 2004) requires a determination of whether human health and environmental effects of continued operations during the license renewal term and refurbishment associated with license renewal on minority populations and low-income populations would be disproportionately high and adverse. This determination will be made by the NRC in each plant-specific SEIS. On the basis of these considerations, the impact of continued operations and other activities on minority populations and low-income populations would depend on site-specific conditions and is therefore a Category 2 issue.

4.10.2 Environmental Consequences of Alternatives to the Proposed Action

Construction—Minority and low-income populations could be directly or indirectly affected by the construction of a new replacement power plant. The extent of effect experienced by these populations is difficult to determine since it would depend on the location of the power plant. For example, increased demand for rental housing during construction could disproportionately affect low-income populations. However, demand for rental housing could be mitigated if the plant is constructed near a metropolitan area. Replacement power plants would likely be sited at existing power plant or industrial brownfield sites, which are often located in or near low-income and minority communities. Construction would also create employment opportunities for minority and low-income individuals. However, construction at a brownfield site could disproportionately affect minority and low-income populations residing in the vicinity of the proposed plant site. Minority and low-income populations may be disproportionately affected by air emissions and noise from construction and by increased truck and commuter traffic.

Increased fossil fuel consumption may affect employment opportunities and environmental conditions in low-income regions that supply the fossil fuel. Power plants that rely on fossil fuels would likely be sited at brownfield sites situated near low-income and minority populations.

Operation—Low-income populations that rely on subsistence consumption of fish and wildlife, living near power plants could be disproportionately affected. Minority and low-income populations may be disproportionately affected by air emissions and noise from facility operation and by increased truck and commuter traffic.

4.11 Waste Management and Pollution Prevention

4.11.1 Environmental Consequences of the Proposed Action—Continued Operations and Refurbishment Activities

The effects of license renewal (including operations and refurbishment that would occur during the license renewal term) on waste management is presented in this section. Baseline conditions at operating reactors are discussed in Section 3.11. License renewal is expected to result in a continuation of these conditions for an extended period commensurate with the license renewal term, usually 20 years. The annual quantities of waste generated during the license renewal term are not expected to change from the amount generated during the current licensed term. However, the accumulated quantity of waste material needing long-term storage or disposal is expected to be approximately 50 percent larger.

The impacts associated with onsite waste management activities at nuclear plants are addressed in other parts of Chapter 4 under various resource discussions. These activities include waste collection, treatment, packaging, and loading onto conveyance vehicles for shipment offsite. These activities are considered to be part of the normal operations at the site. For example, the annual radioactive effluent release reports issued by the sites include a summary of radioactive effluent releases from all the facilities on the site, including the waste management and storage facilities. The same reports also provide data on volume and radioactivity content of solid radioactive waste shipped offsite for processing and disposal. Similarly, the radiological environmental monitoring program conducted at each site measures the direct radiation as well as environmental concentrations of all radionuclides originating at the site as well as background radiation. The impact from the transportation of wastes from the reactor to a third-party waste treatment center or directly to a disposal site is addressed generically in Table S-4 in 10 CFR 51.52 (see Section 4.12.1.1).

The issues that are addressed in this section are

- Low-level radioactive waste (LLW) storage and disposal (issue from the 1996 GEIS);
- Onsite storage of spent nuclear fuel (issue was renamed from the 1996 GEIS);
- Offsite radiological impacts of spent nuclear fuel and high-level waste disposal (issue was renamed from the 1996 GEIS);
- Mixed waste storage and disposal (issue from the 1996 GEIS); and
- Nonradiological waste storage and disposal (issue was renamed from the 1996 GEIS).

These are five of the nine issues evaluated in the 1996 GEIS (NRC 1996) in the chapter on the uranium fuel cycle and waste management. They relate to waste management at all nuclear fuel cycle facilities, including nuclear power plants. The other four issues, which pertain specifically to aspects of the uranium fuel cycle other than the nuclear power plants themselves, are addressed in Section 4.12.1.1. As discussed in Section 4.12.1.1, the other nuclear fuel cycle facilities include uranium mining and milling, uranium hexafluoride (UF_6) production, isotopic enrichment, fuel fabrication, fuel reprocessing, and disposal facilities.

4.11.1.1 Low-Level Waste Storage and Disposal

Section 3.11.1.1 provides the quantities and characteristics of LLW that are normally generated at nuclear plants under routine operating conditions. As stated in the introduction to Section 4.11.1, these baseline conditions are expected to continue during the license renewal term.

Prior to July 1, 2008, most of the LLW generated at reactor sites is shipped offsite for disposal either immediately after generation or after a brief storage period onsite (see Section 3.11.1.1). This trend is expected to continue. However, the Barnwell disposal facility in South Carolina ceased accepting waste from States that are not a part of the Atlantic compact as of July 2008. As a result, the only remaining disposal facility that is available to the nuclear power plant operators in those States is the EnergySolutions facility in Clive, Utah, which is licensed to accept only Class A LLW. Under these circumstances, the options available to the nuclear power plants in those States are to store their Class B and C (and Class A as appropriate) wastes onsite or offsite until a disposal facility becomes available. Such activities are conducted in accordance with NRC regulations and any applicable State or local requirements. One new facility is being developed by the Waste Control Specialists in Texas for the Texas compact, comprised of Texas and Vermont. That facility has been licensed by the State of Texas (an NRC agreement State) and is authorized to dispose of Class A, B, and C LLW (WCS 2009). The owners of the facility are in the process of developing rules governing the disposal of commercial LLW and other types of waste from waste generators in States other than Texas and Vermont. When this process is finalized, the facility could provide an outlet for disposal of LLW generated on those States that used to ship their waste to Barnwell prior to July 2008.

The NRC believes that the comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts on the environment will remain SMALL during the term of a renewed license. The maximum additional onsite land that may be required for LLW storage during the term of a renewed license and associated impacts would be SMALL. Nonradiological impacts on air and water would be negligible. The radiological and nonradiological environmental impacts of long-term disposal of LLW from any individual plant at licensed sites are SMALL. In addition, the NRC concludes that there is reasonable assurance that sufficient LLW disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

On the basis of the above considerations, the impact of LW storage and disposal during the renewal term is considered SMALL for all sites. As in the 1996 GEIS, this issue is considered to be and remains Category 1.

In addition to being generated at the reactor sites, LLW is also generated from the rest of the uranium fuel cycle as part of the front-end operations during the mining and milling of uranium ores and during the steps leading up to the manufacture of new fuel. If the recycling option is made available and the decision is made to reprocess the spent fuel in the United States, the reprocessing operations would also generate LLW. The impacts associated with management of LLW from these other fuel cycle operations are addressed in Table S-3 in 10 CFR 51.51 (see Section 4.12.1.1).

4.11.1.2 Onsite Storage of Spent Nuclear Fuel

The NRC first adopted the Waste Confidence Decision and Rule in 1984. The NRC amended the decision and rule in 1990, reviewed them in 1999, and amended them again in 2010 (49 FR 34694 (August 31, 1984); 55 FR 38474 (September 18, 1990); 64 FR 68005 (December 6, 1999); and 75 FR 81032 and 81037 (December 23, 2010)). The Waste Confidence Decision and Rule are codified in the NRC regulation 10 CFR 51.23. Under the Waste Confidence Rule and Decision, the NRC had determined that spent fuel can be stored onsite safely and with minimal environmental impact for at least 30 years beyond the current licensed operating life (which may include the term of a revised or renewed license) of nuclear power plants. The Commission determined, in the 1996 GEIS, that onsite storage of spent fuel during the term of a renewed operating license is a Category 1 issue. Further, the Commission also concluded in the 1996 GEIS that continued storage of existing spent fuel and storage of spent fuel generated during the license renewal term can be accomplished safely and without significant environmental impacts, as radiation doses will be well within regulatory limits. Thus, the environmental impacts were classified as SMALL for this Category 1 issue. The following new discussion provides information regarding the potential impacts of onsite storage of spent nuclear fuel during the license renewal term.

As discussed in Section 3.11.1.2, spent nuclear fuel is currently stored at reactor sites either in spent fuel pools or in ISFSIs. The storage of spent fuel in spent fuel pools was considered for each plant in the safety and environmental reviews at the construction permit and operating license stage. This onsite storage of spent fuel and high-level waste (HLW) is expected to continue into the foreseeable future.

Interim storage needs vary among plants, with older units likely to lose pool storage capacity sooner than newer ones. Given the uncertainties regarding the final disposition of spent fuel and high-level waste, it is expected that expanded spent fuel storage capacity will be needed at all nuclear power plants.

As discussed above, current and potential environmental impacts from spent fuel storage onsite at the current reactor sites have been studied extensively, are well understood, and the environmental impacts during the license renewal term were found to be SMALL. No new information was found during the development of this GEIS revision that would alter that conclusion.

For the time period after permanent reactor shutdown, the Waste Confidence Decision and Rule represented the Commission's generic determination that spent nuclear fuel can continue to be stored safely and without significant environmental impacts for a period of time after the end of the licensed life for operation of a nuclear power plant (after the permanent shutdown of the power reactor and expiration of the plant's operating license). This generic determination meant that the NRC did not need to consider the storage of spent nuclear fuel after the end of a reactor's licensed life for operation in the NEPA documents that support its reactor and spent-fuel storage license application reviews.

On December 23, 2010, the Commission published a revision of the Waste Confidence Decision and Rule to reflect information gained from experience in the storage of spent nuclear fuel and the increased uncertainty in the siting and construction of a permanent geologic repository for the disposal of spent nuclear fuel and high-level waste. In response to the 2010 Waste Confidence Decision and Rule, the states of New York, New Jersey, Connecticut, and Vermont, along with several other parties, challenged the Commission's NEPA analysis in the decision, which provided the regulatory basis for the rule. On June 8, 2012, the United States Court of Appeals, in *New York v. NRC*, 681 F.3d 471 (D.C. Cir. 2012), vacated the NRC's Waste Confidence Decision and Rule, after finding that it did not comply with NEPA.

The court concluded that the Waste Confidence Decision and Rule is a major federal action necessitating either an EIS or an environmental assessment that results in a "finding of no significant impact." In vacating the 2010 decision and rule, the court identified three specific deficiencies in the analysis:

1. As to the Commission's conclusion that permanent disposal will be available "when necessary," the court held that the Commission did not evaluate the environmental effects of failing to secure permanent disposal;

2. As to the storage of spent fuel on-site at nuclear plants after the expiration of a plant's operating license, the court concluded that the Commission failed to properly examine the risk of spent fuel pool leaks in a forward-looking fashion; and

3. Also related to the post-license storage of spent fuel, the court concluded that the Commission failed to properly examine the consequences of spent fuel pool fires.

In response to the court's ruling, the Commission issued CLI-12-16 on August 7, 2012, in which the Commission determined that it would not issue licenses that rely upon the Waste Confidence Decision and Rule until the issues identified in the court's decision are appropriately addressed by the Commission (NRC 2012). CLI-12-16 provided, however, that the decision not to issue licenses only applied to final license issuance; all licensing reviews and proceedings should continue to move forward. In SRM-COMSECY-12-0016, dated September 6, 2012, the Commission directed the NRC staff to proceed with a rulemaking that includes the development of a generic EIS to support a revised Waste Confidence Decision and Rule and to publish both the EIS and the revised decision and rule in the *Federal Register* within 24 months (by September 6, 2014). The Commission indicated that both the EIS and the revised Waste Confidence Decision and Rule should build on the information already documented in various NRC studies and reports, including the existing environmental assessment that the NRC developed as part of the 2010 Waste Confidence Decision and Rule. The Commission directed that any additional analyses should focus on the three deficiencies identified in the D.C. Circuit's decision. The Commission also directed that the NRC staff provide ample opportunity for public comment on both the draft EIS and the proposed Waste Confidence Decision and Rule.

In accordance with CLI-12-16, the NRC will not approve any site-specific license renewal applications until the deficiencies identified in the D.C. Circuit's decision have been resolved. Two Table B-1 license renewal issues that rely, wholly or in part, upon the Waste Confidence Decision and Rule are the "onsite storage of spent nuclear fuel" and "offsite radiological impacts of spent nuclear fuel and high-level waste disposal." Both of these issues were classified as Category 1 in the 1996 GEIS; the draft revised GEIS that was published for comment in 2009 continued the Category 1 classification for both of these issues. As part of the NRC's response to the *New York v. NRC* decision, the NRC has revised these two issues accordingly.

Specifically, the NRC has revised the Category 1 "Onsite storage of spent nuclear fuel" issue to narrow the period of onsite storage to the license renewal term. In the 1996 GEIS and in the 2009 draft revised GEIS, the NRC relied upon the Waste Confidence Decision and Rule to make a generic finding that spent nuclear fuel could be stored safely onsite with no more than a small environmental impact for the term of the extended license (from approval of the license renewal application to the expiration of the operating license) plus a 30 year period following the permanent shutdown of the power reactor and expiration of the operating license.

The Waste Confidence Decision and Rule provided the basis for the 30 year period following the permanent shutdown of the reactor and expiration of the operating license. The 2010 Waste Confidence Decision and Rule extended this post-reactor shutdown onsite storage period from 30 years to 60 years. Given the *New York v. NRC* decision, and pending the issuance of a generic EIS and revised Waste Confidence Decision and Rule (as directed by SRM-COMSECY-12-0016), the period of onsite storage of spent nuclear fuel following the permanent shutdown of the power reactor and expiration of the operating license is now excluded from this GEIS issue. This issue now only covers the onsite storage of spent fuel during the license renewal term.

4.11.1.3 Offsite Radiological Impacts of Spent Nuclear Fuel and High-Level Waste Disposal

As a result of the *New York v. NRC* decision, and pending the issuance of a generic EIS and revised Waste Confidence Decision and Rule (see the discussion in section 4.11.1.2 above), the NRC has revised the Category 1 issue, “Offsite radiological impacts of spent nuclear fuel and high-level waste disposal.” This issue pertained to the long-term disposal of spent nuclear fuel and high-level waste, including possible disposal in a deep geologic repository. Although the Waste Confidence Decision and Rule did not assess the impacts associated with disposal of spent nuclear fuel and high-level waste in a repository, it did reflect the Commission’s confidence, at the time, in the technical feasibility of a repository and when that repository could have been expected to become available. Without the analysis in the Waste Confidence Decision, the NRC cannot assess how long the spent fuel will need to be stored onsite. Therefore, the NRC reclassifies this GEIS issue from a Category 1 issue with no assigned impact level to an uncategorized issue with an impact level of uncertain.

Moreover, the ultimate disposal of spent nuclear fuel in a potential future geologic repository is a separate and independent licensing action that is outside the regulatory scope of license renewal. However, because of questions and concerns that have been raised regarding this issue during scoping for the revised GEIS, the following discussion provides relevant information with respect to developments pertaining to the consideration of an ultimate repository site for the disposal of spent nuclear fuel.

At the time the 1996 GEIS was issued, there were no established regulatory limits for offsite releases of radionuclides from the ultimate disposal of spent nuclear fuel and HLW, since a candidate repository site had not been established. It was assumed that for such a site, limits would eventually be developed along the lines of those given in the 1995 National Academy of Sciences (NAS) report, *Technical Bases for Yucca Mountain Standards*.

On February 15, 2002, on the basis of a recommendation by the Secretary of Energy, the President recommended the Yucca Mountain site for the development of a repository for the geologic disposal of spent nuclear fuel and HLW. Congress approved this recommendation on July 9, 2002, in Joint Resolution 87, which designated Yucca Mountain as the repository for spent nuclear waste. On July 23, 2002, the President signed Joint Resolution 87 into law. Public Law 107-200, 116 *Statutes at Large* (Stat.) 735, 42 U.S.C. 10135 (note), designates Yucca Mountain as the site for the development of the repository for spent nuclear waste.

Subsequently, the EPA developed Yucca-Mountain-specific repository release standards, which were also adopted by the NRC in 10 CFR Part 63. These standards:

- Establish a dose limit of 15 millirem (0.15 mSv) per year for the first 10,000 years after disposal;
- Establish a dose limit of 100 millirem (1.0 mSv) exposure per year between 10,000 years and 1 million years;
- Require the Department of Energy (DOE) to consider the effects of climate change, earthquakes, volcanoes, and corrosion of the waste packages to safely contain the waste during the 1 million-year period; and
- Consistent with the recommendations of the NAS by establishing a radiological protection standard for this facility at the time of peak dose up to 1 million years after disposal.

On June 3, 2008, the DOE submitted a license application to the NRC, seeking authorization to construct a geologic repository for the disposal of spent nuclear fuel and high-level waste at Yucca Mountain, Nevada. As part of the site characterization and recommendation process for the proposed geologic repository at Yucca Mountain, Nevada, the DOE was required by the Nuclear Waste Policy Act of 1982, 42 U.S.C. 10101 *et seq*. (NWPA), to prepare an EIS. In accordance with the NWPA (42 U.S.C. 10134(f)(4)), the NRC was required to adopt DOE's EIS, to "the extent practicable," as part of any possible NRC construction authorization decision. DOE submitted the following NEPA documents along with its application, which include analyses that address radiological impacts to workers and the public.

- *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (FEIS) (February 2002) (DOE/EIS-0250F) (ML032690321)
- *Final Supplemental Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain,*

Nye County, Nevada (Repository SEIS) (June 2008) (DOE/EIS-0250F-S1) (ML081750191)

The NRC formally accepted for docketing DOE's license application for Yucca Mountain, Nevada on September 8, 2008. In its acceptance, NRC staff also recommended that the Commission adopt, with further supplementation, the EIS and supplements prepared by DOE (73 FR 53284). With respect to radiological impacts, DOE's FEIS and Repository SEIS indicate that the disposal of spent nuclear fuel and high-level waste would be SMALL with exposures well below regulatory limits. However, on March 3, 2010, the U.S. Department of Energy (DOE) filed a motion with the Atomic Safety and Licensing Board (Board) seeking permission to withdraw its application for authorization to construct a high-level waste geological repository at Yucca Mountain, Nevada. The Board denied that request on June 29, 2010, in LBP-10-11 (ADAMS Accession No. ML101800299), whereuponthe parties involved in the preceding filed petitions asking the Commission to uphold or reverse this decision.

On September 9, 2011, the Commission issued a Memorandum and Order, CLI-11-07, stating that it found itself evenly divided on whether to take the affirmative action of overturning or upholding the Board's June 29, 2010, decision. Exercising its inherent supervisory authority, the Commission directed the Board to complete all necessary and appropriate case management activities by September 30, 2011. On September 30, 2011, the Board issued a Memorandum and Order suspending the proceeding.

On October 1, 2010, the NRC staff initiated an orderly closure of its Yucca Mountain activities. As part of the orderly closure, the NRC staff prepared three technical evaluation reports documenting its work.

The NRC's non-sensitive Yucca Mountain-related documents are being preserved and made available to the public as part of the NRC staff's activities to retain the accumulated knowledge and experience gained as a result of its Yucca Mountain-related activities. These documents can be viewed on the NRC's public Web site, http://www.NRC.gov/waste/hlw-disposal.html.

NRC decisions and recommendations concerning the ultimate disposition of spent nuclear fuel are ongoing and outside the scope of license renewal, and as such, of this GEIS.

Separate from the regulatory actions taken by the NRC, in 2009 and early 2010, the president and his administration decided not to proceed with the Yucca Mountain nuclear waste repository. Instead, on January 29, 2010, the Secretary of Energy announced the formation of a Blue Ribbon Commission to conduct a comprehensive review of policies for managing the back end of the nuclear fuel cycle (DOE 2010). The Blue Ribbon Commission will provide advice and make recommendations on issues including alternatives for the storage, processing, and disposal of civilian and defense spent nuclear fuel and HLW. The Blue Ribbon Commission issued its recommendations to the Secretary of Energy on January 26, 2012 (www.brc.gov). The report contained eight key elements:

1. A new, consent-based approach to siting future nuclear waste management facilities.
2. A new organization dedicated solely to implementing the waste management program and empowered with the authority and resources to succeed.
3. Access to the funds nuclear utility ratepayers are providing for the purpose of nuclear waste management.
4. Prompt efforts to develop one or more geologic disposal facilities.
5. Prompt efforts to develop one or more consolidated storage facilities.
6. Prompt efforts to prepare for the eventual large-scale transport of spent nuclear fuel and high-level waste to consolidated storage and disposal facilities when such facilities become available.
7. Support for continued U. S. innovation in nuclear energy technology and for workforce development.
8. Active U. S. leadership in international efforts to address safety, waste management, non-proliferation, and security concerns.

DOE will be the lead Federal agency responsible for developing a new national strategy for nuclear waste management; the NRC will play a supporting role in those areas associated with its regulatory review.

4.11.1.4 Mixed Waste Storage and Disposal

This issue addresses the storage and disposal of mixed waste generated at nuclear power plants and other uranium fuel-cycle facilities during the license renewal term. As discussed in Section 3.11.3, nuclear power plants generate small quantities of mixed waste. Other uranium fuel-cycle facilities are also expected to generate small quantities of mixed waste. Mixed waste is regulated both by the EPA or the authorized State agency under RCRA and by the NRC or the Agreement State agency under the Atomic Energy Act (AEA; Public Law 83-703). The waste is either treated onsite or sent offsite for treatment followed by disposal at a permitted landfill. The comprehensive regulatory controls and the facilities and procedures that are in place at nuclear power plants ensure that the mixed waste is properly handled and stored and that doses to and exposure to toxic materials by the public and the environment are negligible at all plants. License renewal will not increase the small but continuing risk to human health and the environment posed by mixed waste at all plants. The radiological and nonradiological environmental impacts from the long-term disposal of mixed waste at any individual plant at licensed sites are considered SMALL for all sites. The issue was considered a Category 1 issue in the 1996 GEIS, and no new information that would alter this conclusion has been identified.

4.11.1.5 Nonradioactive Waste Storage and Disposal

This issue addresses the storage and disposal of nonradioactive waste generated at commercial nuclear power plants and during the rest of the uranium fuel cycle during the license renewal term. Nonradioactive waste consists of hazardous and nonhazardous waste. Storage and disposal of hazardous waste generated at nuclear plants is discussed in Section 3.11.2. As indicated in that section, nuclear plants generate small quantities of hazardous waste during operation and refurbishment. A special class of hazardous waste, known as universal waste, consisting of commonly used yet hazardous materials (batteries, pesticides, mercury-containing equipment, and lamps), is also generated. Similar types of hazardous wastes are also generated at other uranium fuel-cycle facilities. The management of hazardous wastes generated at all of these facilities, both onsite and offsite, is strictly regulated by the EPA or the responsible State agencies per the requirements of RCRA.

As does any industrial facility, nuclear power plants and the rest of the uranium fuel-cycle facilities also generate nonradioactive nonhazardous waste (see Section 3.11.4). These wastes are managed by following good housekeeping practices and are generally disposed of in local landfills permitted under RCRA Subtitle D regulations.

In the 1996 GEIS, the impacts associated with managing nonradioactive wastes at uranium fuel cycle facilities, including nuclear power plants, were found to be SMALL. It was indicated that no changes to nonradioactive waste generation would be anticipated for license renewal, and that systems and procedures are in place to ensure continued proper handling and disposal of the wastes at all plants. The issue was considered a Category 1 issue in the 1996 GEIS, and no new information that would alter this conclusion has been identified.

4.11.2 Environmental Consequences of Alternatives to the Proposed Action

Construction—Construction-related wastes include various fluids from the onsite maintenance of construction vehicles and equipment (e.g., used lubricating oils, hydraulic fluids, glycol-based coolants, spent lead-acid storage batteries) and incidental chemical wastes from the maintenance of equipment and the application of corrosion-control protective coatings (e.g., solvents, paints, coatings), construction-related debris (e.g., lumber, stone, and brick), and packaging materials (primarily wood and paper). All materials and wastes would be accumulated onsite and disposed of or recycled through licensed offsite disposal and treatment facilities. Life-cycle management of chemicals and wastes generated during construction and pollution prevention initiatives (such as spill prevention plans) will serve to mitigate the impact of wastes. The impacts of waste management are expected to be the same for greenfield, brownfield, and existing nuclear power plant sites.

Operations—Solid wastes would be generated throughout the period of plant operations. The character of wastes would depend on chemical constituents of the fuel, efficiency of combustion, and operational efficiencies of the various air pollution control devices. Wastes routinely associated with the maintenance of mechanical and electrical equipment include: used lubricating oils and hydraulic fluids, cleaning solvents, corrosion control paints and coatings, and dielectric fluids.

4.11.2.1 Fossil Fuel Alternatives

Operations—Solid wastes in the form of coal combustion waste (and, in some instances, flue gas desulfurization sludge and spent catalysts) would be generated during plant operations. The exact character of the coal combustion waste would depend on the chemical constituents of the coal, efficiency of the combustion device, and operational efficiencies of the various air pollution control devices.

4.11.2.2 New Nuclear Alternatives

Operations—Liquid, gaseous, and solid radioactive waste management systems would be used to collect and treat radioactive materials during operations. Waste processing systems would be designed so that radioactive effluents released to the environment would meet the objectives of Appendix I to 10 CFR Part 50. The primary source of radioactive waste from a new nuclear facility is fission products that escape from the fuel rods into the reactor coolant. Coolant could also become contaminated from neutron activation of the primary cooling system. LLW disposal is assumed to occur at an offsite location, while spent fuel would be stored onsite either in spent fuel pool storage or dry cask storage.

Nonradioactive effluent and wastes include cooling water and steam condensate blowdowns that contain various water-treatment chemicals or biocides, wastes from the onsite treatment of cooling water and steam cycle water, floor and equipment drain effluent, stormwater runoff, laboratory waste, trash, hazardous waste, effluent from the sanitary sewer system, miscellaneous gaseous emissions, and liquid and solid effluent. Wastes discharged to waters of the United States would be regulated by NPDES permits. All other wastes would be properly disposed of in accordance with Federal, State, and local regulations. Waste impacts for a nuclear plant are described in Section 4.11.1 and in 10 CFR Part 51, Appendix B, Table B-1. Impacts are expected to be SMALL for all facilities, whether located on greenfield sites, brownfield sites, or at existing nuclear plant sites.

4.11.2.3 Renewable Alternatives

Operations—The operational impacts of alternative energy technologies on waste management are presented in the following subsections.

Geothermal

Small amounts of industrial solid wastes associated with onsite maintenance of equipment and infrastructure would be generated, including: used oils, used glycol-based antifreeze, waste lead-acid storage batteries, spent cleaning solvents, and excess corrosion control coatings. Operational solid wastes could include precipitates (scale) resulting from cooling and depressurized hydrothermal fluids that must be periodically removed from equipment; some precipitates may include naturally occurring radioactive material (NORM).

Wind

Minimal amounts of wastes are generated from the maintenance of wind turbines; wastes consist mainly of spent lubricating and gear oils removed from equipment during routine preventive maintenance, small amounts of battery electrolyte from onsite back-up power systems, and minor amounts of solvents and coatings from ongoing corrosion control activities. Modern turbine designs allow for the easy removal of malfunctioning equipment for replacement and repair; consequently, wastes generated onsite would be limited to preventive maintenance-related wastes.

Biomass

Major operating wastes would include fly ash and bottom ash that results from the combustion of the carbonaceous fuels. Scrubbers for control of sulfur oxide emissions would not be expected to be needed for units combusting wood and energy crops that have little to no sulfur content. Temporary storage of operational solid wastes onsite could affect local ecological systems, especially surface waters.

Municipal Solid Waste, Refuse-Derived Fuel, and Landfill Gas

Small amounts of industrial solid wastes typically associated with maintenance of equipment and infrastructure would be generated, including used oils and lubricants, used glycol-based coolants, waste lead-acid batteries, spent cleaning solvents, and excess corrosion control wastes. Operating wastes also would include small amounts of sanitary wastewaters and sanitary solid wastes from support of the workforces. Toxic constituents in municipal solid waste or refuse-derived fuel could cause solid wastes from air pollution devices to become hazardous due to leachability of toxic constituents. Sanitary wastewater and well as wastewaters from industrial operations would be containerized and removed to offsite treatment; cooling water blowdown and steam cycle blowdown may be discharged to the land surface or to surface impoundments. Temporary storage of operational solid wastes on site could impact local ecological systems, especially surface waters.

Solar Thermal

Spills and leaks of the heat transfer fluids could occur; affected soil would need to be removed and disposed of properly. Routine maintenance-related wastes would be expected. Spills or leaks from electrical components could create waste dielectric fluids (all assumed to be free of PCBs).

Solar Photovoltaic

Proper precautions would have to be made for the disposal of solar cells, although recycling of materials would reduce impacts.

Ocean Wave and Current

Wastes associated with facility operation would include small amounts of wastes related to facility maintenance, including waste lubricating oils, hydraulic fluids, cleaning solvents, and protective corrosion-control paints and coatings. Wastes also include those associated with the application of antifouling agents to the underwater portions of components to control interference by marine organisms. Major repairs of electrical components could result in waste dielectric fluids (mineral oil).

4.12 Impacts Common to All Alternatives

This section describes impacts that are considered common to all alternatives discussed in the GEIS including the proposed action (license renewal) and replacement power alternatives. The continued operation of a nuclear power plant and replacement fossil fueled power plants both involve the mining, processing, and the consumption of fuel, which results in comparative environmental impacts. Environmental impacts associated with power plant fuel cycles are presented in Section 4.12.1. The termination of operations and the decommissioning of a nuclear power plant and replacement fossil fueled power plants as well as renewable energy systems are presented in Section 4.12.2. In addition, greenhouse gas emissions from the nuclear lifecycle as well as replacement fossil fueled power plants and climate change impacts are presented in Section 4.12.3.

4.12.1 Environmental Consequences of Fuel Cycles

This section describes the environmental impacts associated with fuel cycles associated with the proposed action (license renewal) and replacement power alternatives. Most, if not all, replacement power alternatives, including the continued operation of the nuclear power plant during the license renewal term, employ a set of steps in the utilization of its fuel source. These steps can include, but are not limited to, extraction, transformation, transportation, and, combustion. Emissions generally occur at each stage of a fuel cycle. Also, some aspects of the fuel cycle (e.g., storage and disposal) described here are common to each alternative.

4.12.1.1 Uranium Fuel Cycle

In the United States, all currently operating commercial plants are light water reactors and use uranium for fuel. Therefore, in this section and in the rest of this GEIS, the term "uranium fuel cycle" is used interchangeably with "nuclear fuel cycle."

Uranium Fuel Cycle Facilities

The NRC evaluated the environmental impacts that would be associated with operating uranium fuel cycle facilities other than the reactors themselves in two NRC documents: WASH-1248 (NRC 1974) and NUREG-0116 (NRC 1976). The types of facilities considered in these two documents include:

- Uranium mining—facilities where the uranium ore is mined.
- Uranium milling—facilities where the uranium ore is refined to produce uranium concentrates in the form of triuranium octaoxide (U_3O_8).
- Uranium hexafluoride (UF_6) production—facilities where the uranium concentrates are converted to UF_6.
- Isotopic enrichment—facilities where the isotopic ratio of the uranium-235 isotope in natural uranium is increased to meet the requirements of light water reactors.
- Fuel fabrication—facilities where the enriched UF_6 is converted to uranium dioxide (UO_2) and made into sintered UO_2 pellets. The pellets are subsequently encapsulated in fuel rods, and the rods are assembled into fuel assemblies ready to be inserted into the reactors. Two options were considered: (1) carrying out all steps involved in manufacturing the fuel assemblies at the same location and (2) carrying the steps out at two separate facilities (at one facility, UO_2 is produced in powder form from the enriched UF_6, and at the other facility, the fuel assemblies are manufactured).

- Reprocessing—facilities that disassemble the spent fuel assemblies, chop up the fuel rods into small sections, chemically dissolve the spent fuel out of sectioned fuel rod pieces, and chemically separate the spent fuel into reusable uranium, plutonium, and other radionuclides (primarily fission products and actinides).

- Disposal—facilities where the radioactive wastes generated at all fuel cycle facilities including the reactors, are buried. Spent nuclear fuel that is removed from the reactors and not reprocessed was also assumed to be disposed of at a geologic repository.

Environmental Impacts

In addition to impacts occurring at the above facilities, the impacts associated with the transportation of radioactive materials among these facilities, including the transportation of wastes to disposal facilities, were evaluated. The results were summarized in a table and promulgated as Table S-3 in 10 CFR 51.51(b). Table S-3 is provided as Table 4.12-1 for ease of reference. 10 CFR 51.51(a) states:

> Every environmental report prepared for the construction permit stage of a light-water-cooled nuclear power reactor, and submitted on or after September 4, 1979, shall take Table S-3, Table of Uranium Fuel Cycle Environmental Data, as the basis for evaluating the contribution of the environmental effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials and management of low level wastes and high level wastes related to uranium fuel cycle activities to the environmental costs of licensing the nuclear power reactor. Table S-3 shall be included in the environmental report and may be supplemented by a discussion of the environmental significance of the data set forth in the table as weighed in the analysis for the proposed facility.

Specific categories of natural resource use included in Table S-3 relate to land use; water consumption and thermal effluents; radioactive releases; burial of transuranic waste, HLW, and LLW; and radiation doses from transportation and occupational exposures. The contributions in the table for reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle); that is, the cycle that results in the greater impact is used. For each resource area, Table S-3 presents a result that has been integrated over the entire fuel cycle except the reactors. The only exception to this is that the waste quantities provided under the entry called “solids (buried onsite)” also includes wastes generated at the reactor.

The environmental impact values are expressed in terms normalized to show the potential impacts attributable to processing the fuel required for the operation of a 1,000-MWe nuclear power plant for one year at an 80 percent availability factor to produce about 800 MW-yr (0.8 GW-yr) of electricity. This is referred to as 1 reference reactor year (RRY).

A detailed discussion of impacts associated with the production and processing of fuel needed for one reference reactor year operation of the model light water reactor was provided in the 1996 GEIS (NRC 1996). Included in the discussion were the collective offsite radiological impacts that would be associated with radon-222 and technetium-99 releases to the environment during the fuel cycle operations, which Table S-3 does not address. The 1996 GEIS also provided a discussion on the sensitivity of the impacts to recent changes in the fuel cycle (Section 6.2.3 in the 1996 GEIS). For example, when Table S-3 was originally prepared, the model reactor was assumed to be refueled once a year, and the fuel was assumed to remain in the reactor to a burnup level of 33,000 MWd/MTU. The 1996 GEIS discussed the effects of higher fuel burnups up to 62,000 MWd/MTU and the fact that most reactors now refuel once every 18 months or 24 months. The technological changes in the various fuel cycle operations (e.g., the in situ mining of uranium rather than the open pit mining assumed in WASH-1248, and the potential for using more efficient isotopic enrichment processes through the gaseous centrifuge rather than the energy-intensive gaseous diffusion process that was and is still being used in the United States) were also discussed. It was concluded that even though certain fuel cycle operations and fuel management practices have changed over the years, the assumptions and methodology used in preparing Table S-3 were conservative enough that the impacts described by the use of Table S-3 would still be bounding. The NRC believes that this conclusion still holds.

One part of the fuel cycle that was not discussed either in the technical support documents for the original Table S-3 or in the 1996 GEIS was the disposition of the depleted UF_6 tails generated during the enrichment process. Originally, these tails were intended to be used as a feedstock to make fuel for proposed fast breeder reactors. However, the United States abandoned the fast breeder reactor program in 1978. Before the creation of the United States Enrichment Corporation in 1993, DOE was the custodian of all the depleted UF_6 generated in the United States at the three gaseous diffusion plants (in Oak Ridge, Tennessee; Portsmouth, Ohio; and Paducah, Kentucky). DOE prepared several NEPA documents evaluating the impacts associated with the disposition of approximately 700,000 MT (1.54 billion lb) of depleted UF_6 (DOE 1999, 2004a,b, 2007). DOE decided to convert the depleted UF_6 back to U_3O_8 and dispose of it as LLW (DOE 2004c,d). The results of these analyses indicate that the operational impacts of the depleted UF_6 management facilities would not be very different from the impacts estimated for other parts of the fuel cycle in Table S-3. In particular, the impacts of the depleted UF_6 conversion facilities, where the depleted UF_6 is converted to U_3O_8, would be similar to the impacts of the UF_6 production facilities, where U_3O_8 is converted to UF_6. If the depleted uranium oxide is disposed of as LLW, the conversion product corresponding to one reference reactor year would be in addition to the LLW quantities already listed in Table S-3. This value is

Table 4.12-1. Table S-3 Taken from 10 CFR 51.51 on Uranium Fuel Cycle Environmental Data
(Normalized to model light water reactor annual fuel requirement [WASH-1248] or reference reactor year [NUREG-0116])[(a)]

Environmental Considerations	Total	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1,000 MWe Light Water Reactor
Natural Resource Use		
Land (acres)		
Temporarily committed[(b)]	100	
Undisturbed area	79	
Disturbed area	22	Equivalent to a 110 MWe coal-fired power plant.
Permanently committed	13	
Overburden moved (millions of MT)	2.8	Equivalent to 95 MWe coal-fired power plant.
Water (millions of gallons)		
Discharged to air	160	Equal to 2 percent of model 1,000 MWe light water reactor with cooling tower.
Discharged to water bodies	11,090	
Discharged to ground	127	
Total	11,377	Less than 4 percent of model 1,000 MWe light water reactor with once-through cooling.
Fossil Fuel		
Electrical energy (thousands of MW-hour)	323	Less than 5 percent of model 1,000 MWe output.
Equivalent coal (thousands of MT)	118	Equivalent to the consumption of a 45 MWe coal-fired power plant.
Natural gas (millions of scf)	135	Less than 0.4 percent of model 1,000 MWe energy output.
Effluents – Chemical (MT)		
Gases (including entrainment)[(c)]		
SO_x	4,400	
NO_x[(d)]	1,190	Equivalent to emissions from 45 MWe coal-fired plant for a year.
Hydrocarbons	14	
CO	29.6	
Particulates	1,154	
Other gases		

Table 4.12-1. (cont.)

Environmental Considerations	Total	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1,000 MWe Light Water Reactor
F	0.67	Principally from UF_6 production, enrichment, and reprocessing. Concentration within range of State standards and below level that has effects on human health.
HCl	0.014	
Liquids		
SO^-_4	9.9	From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effects are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are NH_3: 600 cfs, NO_3: 20 cfs, fluoride: 70 cfs.
NO^-_3	25.8	
Fluoride	12.9	
Ca^{++}	5.4	
$C1^-$	8.5	
Na^+	12.1	
NH_3	10.0	
Fe	0.4	
Tailings solutions (thousands of MT)	240	From mills only—no significant effluents to environment.
Solids	91,000	Principally from mills—no significant effluents to environment.
Effluents – Radiological (curies)		
Gases (including entrainment)		
Rn-222	–	Presently under reconsideration by the Commission.
Ra-226	0.02	
Th-230	0.02	
Uranium	0.034	
Tritium (thousands)	18.1	
C-14	24	
Kr-85 (thousands)	400	
Ru-106	0.14	Principally from fuel reprocessing plants.
I-129	1.3	
I-131	0.83	
Tc-99	–	Presently under consideration by the Commission.
Fission products and transuranics	0.203	
Liquids		
Uranium and progeny	2.1	Principally from milling—included tailings liquor and returned to ground—no effluents; therefore, no effect on the environment.
Ra-226	0.0034	From UF_6 production.

Table 4.12-1. (cont.)

Environmental Considerations	Total	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1,000 MWe Light Water Reactor
Th-230	0.0015	
Th-234	0.01	From fuel fabrication plants—concentration 10 percent of 10 CFR Part 20 for total processing 26 annual fuel requirements for model light water reactor.
Fission and activation products	5.9×10^{-6}	
Solids (buried onsite)		
Other than high level (shallow)	11,300	9,100 Ci comes from low-level reactor wastes and 1,500 Ci comes from reactor decontamination and decommissioning—buried at land burial facilities. 600 Ci comes from mills—included in tailing returned to ground. Approximately 60 Ci comes from conversion and spent fuel storage. No significant effluent to the environment.
Transuranic and high level waste (deep)	1.1×10^{7}	Buried at Federal Repository.
Effluents – Thermal (billions of Btu)	4,063	Less than 5 percent of model 1,000 MWe light water reactor.
Transportation (person-rem)		
Exposure of workers and general public	2.5	
Occupational exposure	22.6	From reprocessing and waste management.

(a) In some cases where no entry appears, it is clear from the background documents that the matter was addressed and that, in effect, the table should be read as if a specific zero entry had been made. However, there are other areas that are not addressed in the table. Table S-3 does not include health effects from the effluents described in the table, estimates of releases of radon-222 from the uranium fuel cycle, or estimates of technetium-99 released from waste management or reprocessing activities. These issues may be the subject of litigation in the individual licensing proceedings.
Data supporting this table are given in the *Environmental Survey of the Uranium Fuel Cycle*, WASH-1248, April 1974; the *Environmental Survey of the Reprocessing and Waste Management Portion of the LWR Fuel Cycle*,' NUREG-0116 (Supp. 1 to WASH–1248); the *Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle*, NUREG-0216 (Supp. 2 to WASH-1248); and in the record of the final rulemaking pertaining to *Uranium Fuel Cycle Impacts from Spent Fuel Reprocessing and Radioactive Waste Management*, Docket RM-50-3. The contributions from reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor, which are considered in Table S-4 of Section 51.20(g). The contributions from the other steps of the fuel cycle are given in columns A–E of Table S-3A of WASH-1248.
(b) The contributions to temporarily committed land from reprocessing are not prorated over 30 years, since the complete temporary impact accrues regardless of whether the plant services one reactor for one year or 57 reactors for 30 years.
(c) Estimated effluents based upon combustion of equivalent coal for power generation.
(d) 1.2 percent from natural gas use and process.
Source: 10 CFR 51.51

estimated to be approximately 12 Ci (4.4×10^{11} Bq) (35 MT of uranium per RRY multiplied by 0.34 Ci/MT of depleted uranium).

Consideration of Environmental Justice

As stated in NRC's *Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions* (69 FR 52040), "An NRC EJ [environmental justice] analysis should be limited to the impacts associated with the proposed action (i.e., the communities in the vicinity of the proposed action). EJ-related issues differ from site to site and normally cannot be resolved generically. Consequently, EJ, as well as other socioeconomic issues, are normally considered in site-specific EISs. Thus, due to the site-specific nature of an EJ analysis, EJ-related issues are usually not considered during the preparation of a generic or programmatic EIS. EJ assessments would be performed as necessary in the underlying licensing action for each particular facility."

The environmental impacts of various individual operating uranium fuel cycle facilities are addressed in separate EISs prepared by NRC. These documents include analyses that address human health and environmental impacts to minority and low-income populations. Electronic copies of these EISs are available through the NRC's public Web site under Publications Prepared by NRC Staff document collection of the NRC's Electronic Reading Room at http://www.nrc.gov/reading-rm/doc-collections/; and the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html.

Transportation Impacts

The impacts associated with transporting fresh fuel to one 1,000 MWe model light water reactor and with transporting spent fuel and radioactive waste (LLW and mixed waste) from that light water reactor are provided in Table S-4 in 10 CFR 51.52. Similar to Table S-3, and as indicated in 10 CFR 51.52, every environmental report prepared for the construction permit stage of a commercial nuclear power plant must contain a statement concerning the transport of fuel and radioactive waste to and from the reactor. A similar statement is also required in license renewal applications. Table S-4 forms the basis of such a statement and is presented as Table 4.12-2.

A discussion of the values included in Table S-4 and how they may change during the license renewal term was included in Section 6.3 of the 1996 GEIS. However, after the 1996 GEIS was issued and during the rulemaking process for codifying Table B-1 in 10 CFR Part 51, a number of comments were received from the public that raised some questions about the adequacy of Table S-4 for license renewal application reviews. As a result, the NRC reevaluated the transportation issues and the adequacy of Table S-4 for license renewal application reviews. In

1999, the NRC issued an addendum to the 1996 GEIS (NRC 1999a) in which the agency evaluated the applicability of Table S-4 to future license renewal proceedings, given that the spent fuel is likely to be shipped to a single repository (as opposed to several destinations, as originally assumed in the preparation of Table S-4) and given that shipments of spent fuel are likely to involve more highly enriched fresh fuel (more than 4 percent as assumed in Table S-4) and higher-burnup spent fuel (higher than 33,000 MWd/MTU as assumed in Table S-4). In the addendum, the NRC evaluated the impacts of transporting the spent fuel from reactor sites to the candidate repository at Yucca Mountain and the impacts of shipping more highly enriched fresh fuel and higher-burnup spent fuel. On the basis of the evaluations, the NRC concluded that the values given in Table S-4 would still be bounding, as long as the (1) enrichment of the fresh fuel was 5 percent or less, (2) burnup of the spent fuel was 62,000 MWd/MTU or less, and

Table 4.12-2. Table S-4 Taken from 10 CFR 51.52 on the Environmental Impact of Transporting Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor[(a)]

Normal Conditions of Transport			
		Environmental Impact	
Heat (per irradiated fuel cask in transit)		250,000 Btu/hr	
Weight (governed by Federal or State restrictions)		73,000 lb per truck; 100 tons per cask per rail car	
Traffic density:			
Truck		Less than 1 per day	
Rail		Less than 3 per month	
Exposed Population	**Estimated No. of Persons Exposed**	**Range of Doses to Exposed Individuals[(b)] (per reactor year)**	**Cumulative Dose to Exposed Population (per reactor year)[(c)]**
Transportation workers	200	0.01 to 300 millirem	4 person-rem
General public:			
Onlookers	1,100	0.003 to 1.3 millirem	3 person-rem
Along route	600,000	0.0001 to 0.06 millirem	
Accidents in Transport			
		Environmental Risk	
Radiological effects		Small[(d)]	
Common (nonradiological) causes		1 fatal injury in 100 reactor years; 1 nonfatal injury in 10 reactor years; $475 property damage per reactor year	

(a) Data supporting this table are given in the Commission's *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants*, WASH-1238, December 1972, and Supp. 1, NUREG-75/038, April 1975.
(b) The Federal Radiation Council has recommended that the radiation doses from all sources of radiation other than natural background and medical exposures should be limited to 5,000 millirem per year for individuals as a result of occupational exposure and should be limited to 500 millirem per year for individuals in the general population. The dose to individuals due to average natural background radiation is about 130 millirem per year.
(c) Man-rem is an expression for the summation of whole body doses to individuals in a group. Thus, if each member of a population group of 1,000 people received a dose of 0.001 rem (1 millirem), or if 2 people received a dose of 0.5 rem (500 millirem) each, the total man-rem dose in each case would be 1 man-rem.
(d) Although the environmental risk of radiological effects stemming from transportation accidents is currently incapable of being numerically quantified, the risk remains small, regardless of whether it is being applied to a single reactor or a multireactor site.
Source: 10 CFR 51.52

(3) higher-burnup spent fuel (higher than 33,000 MWd/MTU) was cooled for at least 5 years before being shipped offsite. The conditions evaluated in Addendum 1 have not changed, and no new conditions have been introduced that would alter the conclusions in Addendum 1 (NRC 1999a). A later study found that the impacts presented in Table S-4 would bound the potential environmental impacts that would be associated with transportation of spent nuclear fuel with up to 75,000 MWd/MTU burnup, provided that the fuel is cooled for at least 5 years before shipment (Ramsdell et al. 2001). Table S-4 as currently encoded in 10 CFR 51.52 is provided.

Consideration of Environmental Justice

The human health impacts of transporting spent nuclear fuel are addressed in an addendum to the 1996 GEIS (NRC 1999a) in which the agency evaluated the applicability of Table S-4 to future license renewal proceedings given that the spent fuel is likely to be shipped to a single repository. As part of the site characterization and recommendation process for the proposed geologic repository at Yucca Mountain, Nevada, the DOE is required by the Nuclear Waste Policy Act of 1982 to prepare an EIS. By law, the NRC is required to adopt DOE's EIS, to "the extent practicable," as part of any possible NRC construction authorization decision. As a result, DOE prepared and submitted to NRC the *Supplemental Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (Repository SEIS) DOE/EIS-0250F-S1) (DOE 2008). This document includes analyses that address human health and environmental impacts to minority and low-income populations.

As noted in DOE's Repository SEIS, shipments of spent nuclear fuel (as well as fresh fuel) would use the nation's existing railroads and highways. DOE estimates that transportation-related impacts to land use; air quality; hydrology; biological resources and soils; cultural resources; socioeconomics; noise and vibration; aesthetics; utilities, energy, and materials; and waste management would be SMALL. The small effect on the population as a whole would be likely for any segment of the population, including minority and low-income populations, as well as members of American Indian Tribes.

DOE did not identify any potentially high and adverse impacts to members of the public from the transport of spent nuclear fuel. DOE determined that subsections of the population, including minority or low-income populations, would not receive disproportionate impacts, and no unique exposure pathways, sensitivities, or cultural practices that would expose minority or low-income populations to disproportionately high and adverse impacts were identified. DOE concluded that no disproportionately high and adverse impacts would result from the national transportation of spent nuclear fuel to Yucca Mountain (DOE 2008). On September 8, 2008, NRC staff recommended that the Commission adopt, with supplementation, DOE's Repository EIS and supplements (73 FR 53284).

In light of the recent DOE decision to not proceed with the Yucca Mountain nuclear waste repository and conduct a comprehensive reevaluation of policies for managing the spent fuel from the nation's nuclear power plants (see Section 4.11.1.3), some or all of the evaluations DOE did for Yucca Mountain may have to be redone.

Environmental Impact Issues of the Uranium Fuel Cycle

Nuclear fuel is needed for the operation of light water reactors during the license renewal term in the same way that it is needed during the current license period. Therefore, the factors that affect the data presented in Tables S-3 and S-4 of 10 CFR 51.51 and 51.52, respectively, do not change whether a light water reactor is operating under its original license or a renewed license. In the 1996 GEIS, there are nine issues that relate to uranium fuel cycle and waste management. Five of these issues that relate to waste management are addressed in Section 4.11.1.

The remaining four impact issues include the following:

- Offsite radiological impacts—individual impacts from other than the disposal of spent fuel and high-level waste (issue was renamed from the 1996 GEIS);
- Offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste (issue was renamed from the 1996 GEIS);
- Nonradiological impacts of the uranium fuel cycle (issue was renamed from the 1996 GEIS); and
- Transportation (issue from the 1996 GEIS).

Offsite Radiological Impacts—Individual Impacts from Other than the Disposal of Spent Fuel and High-Level Waste

This issue addresses the radiological impacts on individuals who live near uranium fuel cycle facilities. The primary indicators of impact are the concentrations of radionuclides in the effluents from the fuel cycle facilities and the radiological doses received by an MEI on the site boundary or at some location away from the site boundary. As discussed in Section 3.9.1, an MEI can be exposed to radiation from radionuclides found in the effluents of nuclear fuel cycle facilities and from radiation "shine" from buildings, storage facilities, and storage tanks containing radioactive material. The basis for establishing the significance of individual effects is the comparison of the releases in the effluents and the MEI doses with the permissible levels in applicable regulations. The analyses performed by the NRC in the preparation of Table S-3 and found in the 1996 GEIS indicate that as long as the facilities operate under a valid license issued by either the NRC or an agreement State, the individual effects will meet the applicable regulations. On the basis of these considerations, the NRC has concluded that the impacts on individuals from radioactive gaseous and liquid releases during the license renewal term would remain at or below the NRC's regulatory limits. Accordingly, the NRC concludes that offsite radiological impacts of the uranium fuel cycle (individual effects from sources other than the disposal of spent fuel and high-level waste) are SMALL. The efforts to keep the releases and doses at ALARA will continue to apply to fuel-cycle-related activities. This was considered a Category 1 issue in the 1996 GEIS. No new information has been identified that would alter this conclusion.

Offsite Radiological Impacts—Collective Impacts from Other than the Disposal of Spent Fuel and High-Level Waste

The focus of this issue is the collective radiological doses to and health effects on the general public resulting from uranium fuel cycle facilities over the license renewal term. The radiological doses received by the general public are calculated on the basis of releases from the facilities to the environment, as provided in Table S-3. These estimates were provided in the 1996 GEIS for the gaseous and liquid releases listed in Table S-3 as well as for radon-222 and technetium-99 releases, which are not listed in Table S-3. The population dose commitments were normalized for each year of operation of the model 1,000-MWe LWR (RRY).

On the basis of the analyses provided in the 1996 GEIS, the estimated involuntary 100-year dose commitment to the U.S. population resulting from the radioactive gaseous releases from uranium fuel cycle facilities (excluding the reactors and releases of Rn-222 and Tc-99) was estimated to be 400 person-rem (4 person-Sv) for 1 RRY. Similarly, the environmental dose commitment to the U.S. population from the liquid releases was estimated to be 200 person-rem (3 person-Sv) per RRY. As a result, the total estimated involuntary 100-year dose commitment to the U.S. population from radioactive gaseous and liquid releases listed in Table S-3 was given as 600 person-rem (6 person-Sv) per RRY (see Section 6.2.2 of NRC 1996).

The 1996 GEIS also provided a detailed analysis of potential doses to the U.S. population from Rn-222 releases, which primarily occur during mining and milling operations and as emissions from mill tailings, and Tc-99 releases, which primarily occur during the enrichment process (Section 6.2.2 of NRC 1996). The U.S. population doses resulting from the Rn-222 releases and Tc-99 releases for 1 RRY are summarized in Table 4.12-3. The total population dose from all releases to the environment, including the Rn-222 and Tc-99 releases, is given as 938.6 person-rem (9.386 person-Sv) per RRY. Because of an oversight in the 1996 GEIS, the sum of population doses was given as 740 person-rem, and the total dose over the 20-year renewal period was listed as 14,800 person-rem (148 person-Sv) (740 person-rem per RRY multiplied by 20 years). The correct values would be approximately 940 person-rem per RRY and 18,800 person-rem (188 person-Sv) for 20 years.

Table 4.12-3. Population Doses from Uranium Fuel Cycle Facilities Normalized to One Reference Reactor Year

Source	Collective Dose (person-rem)[(a)]
Gaseous releases	400
Liquid releases	200
Rn-222 releases from uranium mining and milling	140
Rn-222 releases from unreclaimed open-pit mines	96
Rn-222 releases from stabilized tailings piles	2.6
Tc-99 releases from enrichment plants	100
Total	938.6

(a) To convert person-rem to person-Sv, multiply by 0.01.
Source: modified from NRC 1996

As discussed in the 1996 GEIS, the dose estimates given above were based on highly conservative assumptions (i.e., the doses are overestimated). In actuality, the doses received by most members of the public would be so small that they would be indistinguishable from the variations in natural background radiation. The 1996 GEIS further estimated the health effects on the general public in terms of cancer fatalities by multiplying the calculated doses by risk conversion factors obtained from the literature. The estimated health effect was stated as 0.6 cancer fatality per RRY, or 12 cancer fatalities for each additional 20-year LWR operating term. The 1996 GEIS also stated that these estimates were highly uncertain and that much of the calculated doses, especially the contribution of radon releases from mines and tailing piles, consisted of tiny doses summed over large populations. It was stated that this practice may result in health effect estimates that may not be meaningful.

There are no regulatory limits applicable to collective doses to the general public from fuel cycle facilities. All regulatory limits are based on individual doses. All fuel cycle facilities are designed and operated to meet the applicable regulatory limits.

As discussed in the 1996 GEIS, despite the lack of definitive data, some judgment as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgment in every case. The Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the collective effects of the fuel cycle; this issue was considered Category 1. No new information has been identified that would alter this conclusion.

Nonradiological Impacts of the Uranium Fuel Cycle

This section addresses the nonradiological impacts associated with the uranium fuel cycle facilities as they relate to license renewal. Data on the nonradiological impacts of the fuel cycle are provided in Table S-3. These data cover land use, water use, fossil fuel use, and chemical effluents. The significance of the environmental impacts associated with these data was evaluated in the 1996 GEIS on the basis of several relative comparisons. The land requirements were compared to those for a coal-fired power plant that could be built to replace the nuclear capacity if the operating license is not renewed. Water requirements for the uranium fuel cycle were compared to the annual requirements for a nuclear power plant. The amount of fossil fuel (coal and natural gas) consumed to produce electrical energy and process heat during the various phases of the uranium fuel cycle was compared to the amount of fossil fuel that would have been used if the electrical output from the nuclear plant were supplied by a coal-fired plant. Similarly, the gaseous effluents SO_2, NO, hydrocarbons, CO, and PM released as a consequence of the coal-fired electrical energy used in the uranium fuel cycle were compared with equivalent quantities of the same effluents that would be released from a 45-MWe coal-fired plant. It was noted that the impacts associated with uses of all of the above resources would be SMALL. Any impacts associated with nonradiological liquid releases from the fuel cycle facilities would also be SMALL. As a result, the aggregate nonradiological impact of the uranium fuel cycle resulting from the renewal of an operating license for a plant would be SMALL, and it was considered a Category 1 issue in the 1996 GEIS. No new information has been identified that would alter this conclusion.

Transportation

This section addresses the impacts associated with transportation of fuel and waste to and from one light water reactor during the license renewal term. Table S-4 in 10 CFR 51.52 forms the basis for analysis of these impacts in evaluating the applications for license renewal from owners of light water reactors. As discussed previously in this section, the applicability of Table S-4 for license renewal applications was extensively studied in the 1996 GEIS (NRC 1996) and its Addendum 1 (NRC 1999a). The impacts were found to be SMALL, and the findings were stated as follows:

> The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with average burnup for the peak rod to current levels approved by NRC up to 62,000 MWd/MTU and the cumulative impacts of transporting high-level waste to a single repository, such as Yucca Mountain, Nevada are found to be consistent with the impact values contained in 10 CFR 51.52(c), Summary Table S-4, "Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor." If fuel enrichment or burnup

conditions are not met, the applicant must submit an assessment of the implications for the environmental impact values reported in 10 CFR 51.52.

The issue was assigned to Category 1. No new information has been identified that would alter this conclusion.

4.12.1.2 Replacement Power Alternative Fuel Cycles

Fossil Fuel Energy Alternatives

The environmental consequences of the fuel cycle for a fossil-fuel-fired plant result from the initial extraction of the fuel from its natural setting, fuel cleaning and processing, transport of the fuel to the facility, and management and ultimate disposal of solid wastes resulting from combustion of the fuel.

The environmental impacts of coal mining vary with the location and type of mining technology employed, but generally includes:

- Significant change in land uses, especially when surface mining is employed.
- Degradation of visual resource values.
- Air quality impacts, including release of criteria pollutants from vehicles and equipment, release of fugitive dust from ground disturbance and vehicle travel on unpaved surfaces, release of VOCs from the storage and dispensing of vehicle and equipment fuels and the use of solvents and coatings in maintenance activities, and release of coalbed methane into the atmosphere as coal seams are exposed and overburden removed.
- Noise impacts from the operation of vehicles and equipment and the possible use of explosives.
- Impacts on geology and soils due to land clearing, excavations, soil and overburden stockpiling (for strip mining operations), and mining.
- Water resources impacts, including degradation of surface water quality due to increased sediment and runoff to surface water bodies, possible degradation of groundwater resources due to consumptive use and potential contamination (especially when shaft mining techniques are employed), as well as generation of wastewater from coal cleaning operations and other supporting industrial activities.

- Ecological impacts, including extensive loss of natural habitat, loss of native vegetative cover, disturbance of wildlife, possible introduction of invasive species, changes to surface water hydrology, and degradation of aquatic systems.

- Impacts on historic and cultural resources within the mine footprint, as well as additional potential impacts resulting from auxiliary facilities and appurtenances (e.g., access roads, rail spurs).

- Direct socioeconomic impacts from employment of the workforce and indirect impacts from increased employment in service and support industries.

- Potential environmental justice impacts as a result of the presence of low-income or minority populations in the surrounding communities and/or within the workforce.

- Potential health impacts on workers from exposure to airborne dust, gases such as methane, and exhaust from internal combustion engines on vehicles and mining machinery.

- Generation of coal wastes and industrial wastes associated with the maintenance of vehicles and equipment; increased potential for spills of fuels from onsite fuel storage and dispensing.

New Nuclear Energy Alternatives

Environmental impacts of the fuel cycle result from the initial extraction of the fuel from its natural setting, transport of the fuel to the facility, and management and ultimate disposal of solid wastes resulting from combustion of the fuel. For the fuel cycle associated with a nuclear power plant, these activities include uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials, and management of low-level wastes and high-level wastes (10 CFR Part 51). The NRC has summarized environmental data associated with the uranium fuel cycle in Table S-3 of 10 CFR 51.51. The analysis provides a basis for evaluating environmental effects of the fuel cycle for all nuclear power plants, regardless of site location. The information is based on a 1000-MW LWR with an 80 percent capacity factor. The impacts associated with the transportation of fuel and waste to and from a power reactor are summarized in Table S-4 of 10 CFR 51.52. Detailed analysis of the uranium fuel cycle is also considered in Section 4.12.1.1. Although it is specific to the impacts of license renewal, it is applicable to the new nuclear plant alternative because the advanced reactor designs use the same type of fuel as existing operational designs. One difference may be that the new reactor may have a power rating of greater than 1,000 MWe, which may exceed the power rating of the existing reactor. In those cases, the impacts would be proportionally higher. However, all impacts associated with the uranium fuel cycle, as discussed in Section 4.12.1.2, would still be SMALL.

Renewable Energy Alternatives

The term "fuel cycle" has varying degrees of relevance for renewable energy facilities. Clearly, the term has meaning for renewable energy technologies that rely on combustion of fuels such as biomass grown or harvested for the express purpose of power production. The term is somewhat more difficult to define for renewable technologies such as wind, solar, geothermal, and ocean wave and current. Those natural energy resources exist regardless of any effort to harvest them for electricity production. The common technological strategy for harvesting energy from such natural resources is to convert the kinetic or thermal energy inherent in that resource to mechanical energy or torque. The torque is then applied directly (e.g., as in the case of a wind turbine) or indirectly (e.g., for those facilities that utilize conventional steam cycles to drive turbines that drive generators) to produce electricity. However, because those renewable technologies capture very small fractions of the total kinetic or thermal energy contained in those resources, impacts from the presence or absence of the renewable energy technology are often indistinguishable.

Environmental consequences of fuel cycles for biomass (e.g., energy crops, wood wastes, municipal solid waste, refuse-derived fuel, landfill gas) include the following:

- Land use impacts from the growing and harvesting of the energy crops.
- Reduced impacts on land from the avoidance of land disposal of anthropogenic biomass feedstocks such as municipal solid waste and refuse-derived fuel.
- Visual impacts from the establishment of farm fields and forest areas and processing facilities for the growing, harvesting, and preparation of biomass feedstocks.
- Air impacts from operation of vehicles and equipment used in the planting, cultivating, and harvesting of energy crops.
- Reductions in greenhouse gas emissions from landfills as a result of the capture and destruction by combustion of landfill gas for energy production.
- Removal of greenhouse gases from the air (e.g., CO_2) by growing crops.
- Noise impacts from the operation of agriculture and silviculture equipment and transport vehicles in otherwise rural settings with low ambient noise levels.

- Soil impacts from the cultivation of fields and the potential for increased sediment in precipitation runoff.

- Hydrologic impacts from irrigation of the energy crops; impacts on groundwater resources from water removal for agricultural or silvicultural purposes or industrial water uses associated with the preparation of biomass feedstocks.

- Ecological impacts from the loss of habitat resulting from crop production; loss of hydrologic resources due to diversion for irrigation purposes; potential intrusion of invasive species on disturbed land surfaces, and potential contamination of adjacent habitat by pesticide and fertilizer runoff.

- Ecological impacts from the alteration of habitat due to human presence and activities in agricultural and silvicultural areas.

- Historic and cultural resource impacts from inadvertent destruction of resources in virgin fields that have not undergone appropriate efforts to survey, identify, and relocate cultural resources that may be present.

- Human health impacts from the exposure of workers to pesticides and fertilizers used in growing biomass fuels; work around mechanical planting, cultivating, and harvesting equipment; work in weather extremes; and exposure to dangerous plants and wildlife.

- Waste impacts in the form of residual wastes from the application of pesticides and fertilizers and wastes associated with the routine maintenance of equipment and vehicles used in crop production and transport (used lubricating oils, hydraulic fluids, glycol-based coolants, and battery electrolytes from maintenance of equipment and vehicles with internal combustion engines).

- Positive economic impacts from the creation of jobs in the agriculture, silviculture, and transportation sectors.

4.12.2 Environmental Consequences of Terminating Power Plant Operations and Decommissioning

This section describes the environmental impacts associated with the termination of operations and the decommissioning of a nuclear power plant and replacement power alternatives. All operating power plants will terminate operations and be decommissioned at some point after the end of their operating life or after a decision is made to cease operations. For the proposed action, license renewal would delay this eventuality for an additional 20 years beyond the current license period. The impacts of decommissioning nuclear plants were evaluated in the

Generic Environmental Impact Statement for Decommissioning Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors, NUREG-0586 (NRC 2002a). For replacement power alternatives, the environmental consequences from the termination of power plant operations and the decommissioning a fossil fuel energy facility or renewable energy systems would be similar.

4.12.2.1 Termination of Operations and Decommissioning of Existing Nuclear Power Plants

This section describes and discusses the environmental consequences of terminating nuclear power plant operations and decommissioning, but the only impacts attributable to the proposed action (license renewal) are the effects of an additional 20 years of operations on the impacts of decommissioning. The majority of the impacts associated with plant operations would cease with reactor shutdown; however, some impacts would remain unchanged, while others would continue at reduced or altered levels. Some new impacts might also result directly from terminating nuclear power plant operations. Ancillary systems that are dedicated solely to reactor operations would cease operations completely; however, impacts from their physical presence could continue if they were not removed coincident with reactor shutdown. For sites with more than one unit, the operation of any ancillary systems that supported the units that continued to operate would be reduced in proportion to the reduced demand on them but would not stop entirely. Impacts associated with the mere physical presence of dedicated systems that remained in place or shared ancillary systems that continued to operate would remain unchanged.

Terminating nuclear power plant operations would result in the cessation of actions necessary to maintain the reactor, as well as a significant reduction in the workforce. NRC presumes that terminating nuclear power plant operations would not immediately lead to the dismantlement of the reactor or other infrastructure, much of which would still be in use to support other units onsite that continued to operate. Even for sites with just one unit, some facilities would remain in operation to ensure that the site was maintained in safe shutdown condition. Electrical generators might continue to operate as synchronous condensers to stabilize voltage on the bulk electricity grid to which the reactor was connected.

Three decommissioning options were analyzed in the decommissioning GEIS (NRC 2002a) and are referenced in this section: DECON, SAFSTOR, and ENTOMB. In the DECON option, the equipment, structures, and portions of a facility and site containing radioactive contaminants are removed and safety buried in a low-level radioactive waste landfill or decontaminated to a level that permits the property to be released for unrestricted use shortly after cessation of operations. In the SAFSTOR option, the nuclear facility is placed and maintained in such condition that the nuclear facility can be safely stored and subsequently decontaminated to levels that permit release for restricted or unrestricted use. Finally, with the ENTOMB option, radioactive contaminants are encased in a structurally long-lived material, such as concrete. The entombment structure is appropriately maintained and continued surveillance is carried out until the radioactivity decays to a level permitting unrestricted release of the property.

Land Use

The termination of nuclear power plant operations would cause a reduction in the workforce at a nuclear plant, and the value placed on the facility for tax purposes would likely depreciate. The impact on taxing authorities that receive revenue from the nuclear power plant would depend on the percentage of revenue that they derived from the plant. Depending on the future need to replace electrical generating capacity, a replacement power plant could change the tax base and impact offsite land use. However, existing substations are expected to remain and be maintained after the termination of reactor operations to support the power grid.

Temporary onsite land use changes during decommissioning are anticipated to be comparable to changes that occur during construction and operations and would not require additional land. The major activities that require land temporarily include the staging of equipment, accommodation of workers (e.g., parking, training, site security access, office space, changing facilities), and removal of large components. The locations of these areas would depend on the layout of the plant. Temporary changes in onsite land use would not change the fundamental use of the reactor site.

There would be no difference in offsite land use impacts whether decommissioning occurred at the end of its current 40-year operating license or following a 20-year license renewal term. In either case, the impact of license renewal after terminating plant operations and decommissioning on onsite and offsite land use would be SMALL and generic at all nuclear plants.

Visual Resources

Terminating nuclear power plant operations would not change the visual appearance of the nuclear power plant. The most notable change, however, would be the elimination of the condensate plumes from cooling towers (under certain meteorological conditions). The appearance of the plant would change as structures are removed.

Decommissioning may involve the demolition and dismantlement of one or more of the main buildings or structures at a nuclear power plant. A case study conducted for the 1996 GEIS found a limited number of situations in which the presence of nuclear power plants fostered perceptions of adverse impacts on visual resources. License renewal would delay decommissioning and prolong the visual impact. As discussed in the decommissioning GEIS

(NRC 2002a), the visual impact of the nuclear plant site may not improve following decommissioning because the site could remain in industrial use.

Transmission lines and ROWs are expected to continue operating and to cause little or no additional impacts beyond those that have already occurred. A 20-year delay caused by license renewal would have no visual impact from continued transmission line operation.

Visual resource impacts associated with terminating plant operations and decommissioning after a 20-year license renewal will not change as a consequence of the delay. The impact of license renewal on visual resources would be SMALL for all nuclear plants.

Air Quality

After the termination of operations, air emissions from the nuclear power plant would continue, but at greatly reduced levels. Air quality impacts would range from very small and would approach undetectable levels. Natural or mechanical draft cooling tower drift would be greatly reduced or would be eliminated. Air emissions from ancillary facility operations (e.g., boilers, emergency diesel generators) would continue until decommissioning.

The NRC evaluated the following activities in the decommissioning GEIS (NRC 2002a) that could impact air quality:

- Worker transportation to and from the site;
- Demolition of buildings and structures, including new structures added during refurbishment;
- Shipment of materials and debris to offsite locations;
- Operation of concrete batch plants (e.g., ENTOMB decommissioning option);
- Dismantling of systems and removing of equipment; and
- Movement and open storage of material onsite.

These activities typically occur over a period of years, from the time the facility ceases operation until the decommissioning is complete. The magnitude and the timing of the potential impacts of each decommissioning activity would vary from plant to plant.

Building and major plant structure demolition and the operation of the batch plant during decommissioning would have the greatest impact on air quality. Fugitive dust would vary in the size of the particles released. Depending on meteorological conditions, larger particles would settle to the ground near the demolition site.

Demolition would generally be limited to a small number of short-duration events. Mitigation measures, such as synchronized scheduling and the application of water sprays or chemical dust suppressants, could minimize the amount of fugitive dust released from the site.

The ENTOMB decommissioning option would require large amounts of concrete and aggregate. Unloading dry cement at the concrete batch plant and loading mixers or trucks would generate large amounts of dust. Depending on meteorological conditions, large particles of dust would settle out of the air quickly, and air quality impacts would be localized near the concrete batch plant. Dust control measures used at concrete batch plants include enclosed dumping and unloading areas and conveyors and filters and water sprays.

The NRC concluded that the impact of decommissioning on air quality would be SMALL for all plants in the decommissioning GEIS (NRC 2002a). The impact on air quality after the license renewal term is not expected to be different from the impact that would have occurred without license renewal.

Noise

During decommissioning, noise would generally be far enough away from sensitive receptors outside the plant boundaries that the noise would be attenuated to nearly ambient levels and would be scarcely noticeable offsite (NRC 2002a). However, during the demolition of concrete, the noise levels offsite could be loud enough (60 to 65 dB at the nearest receptor site) that activities might need to be curtailed during early morning and evening hours. It is highly unlikely, on the basis of past decommissioning experience, that the offsite noise level from a plant during decommissioning would be sufficient to cause hearing loss. However, in one case, noise from decommissioning of a spent fuel pool's cooling system was reported to be up to 107 dB near the source, but it dropped to 50 dB at distances less than 1 mi (1.6 km) away (NRC 2002a). Nearby residents complained about these noise levels; engineering changes were made to the fans that were causing the noise, and the issue was resolved. Noise abatement procedures could also be used during decommissioning in order to reduce noise.

The NRC concluded that the noise impact of decommissioning would be SMALL for all plants in the decommissioning GEIS (NRC 2002a). The noise impact from terminating nuclear plant operations and decommissioning after the license renewal is not expected to be different from the impact that would have occurred without license renewal.

Geology and Soils

Termination of nuclear plant operations is not expected to impact geology and soils. Heavy construction equipment would be engaged in demolition activities during decommissioning. These vehicles would primarily use paved surfaces, but would also cross open ground in some locations. This would create the possibility for soil erosion from areas formerly covered with lawns or natural grasses. The demolition and removal of buildings, foundation slabs, parking lots, and roads, would expose more soil to possible erosion.

High slopes and surface runoff increase erosion potential. The soil distribution across a site may include some soils that are more susceptible to water or wind erosion. The loss of soil increases the turbidity in surface water draining off the site.

Erosion problems could be mitigated by using BMPs during decommissioning. These include, but are not limited to, minimizing the amount of disturbed land; stockpiling topsoil before construction or regrading; replacing the topsoil and adding seed and mulch in disturbed areas as soon as possible after disturbance; using silt fences to reduce sediment loading to surface water; using check dams to minimize the erosive power of drainages or creeks; and installing proper culvert outlets to minimize erosion in creeks.

Site geologic resources would not be affected by decommissioning. Geologic resources in the form of gravel or crushed stone might be needed to construct temporary roads that would be used by the heavy equipment involved in demolition.

The impact from terminating plant operations and decommissioning on geology and soils after a license renewal is not expected to be significantly different from the impacts that would have occurred without license renewal.

Water Resources—Surface Water and Groundwater

After the termination of plant operations, water use would be dramatically reduced; however, water demands would continue for the service water system to support such activities as temperature control of the spent fuel pool and other miscellaneous industrial maintenance applications. Surface water or groundwater intake and consumptive use would be very low compared with use during the operational phase. Discharge of liquid wastes and biocides would also be proportionately reduced.

Because the site workforce would be reduced, the volume of sanitary sewage effluent would be less than it had been during the operational period. Pumping rates for groundwater used for the potable water system after the termination of plant operations would also decrease because of the reduced workforce.

Impacts to site hydrology and water quality from soil erosion and storm events are expected to be unchanged from the operational period. Such erosion would be mitigated as part of general site maintenance during any phase in the power plant's life cycle.

The possibility of groundwater becoming contaminated through chemical spills or radionuclide release would be smaller after operations cease.

Dewatering, if needed to maintain the stability of structure foundations, is expected to continue as it did during the operational phase.

During decommissioning, the activities that have the potential to affect water use include:

- Maintenance of the spent fuel pool,
- Staffing changes (generally the staff size is decreased),
- Cooling of cutting equipment during removal of the reactor vessel and internals,
- High-pressure sprays of water on surfaces during decontamination,
- Dust suppression during destruction of structures, and
- The making of concrete for facility entombment.

The activities identified in the decommissioning GEIS (NRC 2002a) that have the potential to affect water quality include:

- Maintenance of the spent fuel pool,
- Draining and flushing of the cooling systems and processing of the liquid,
- High-pressure sprays of water on surfaces during decontamination, and
- Management of water used in dust suppression during destruction of structures.

At individual sites, the source of water for each of these uses may be surface water or groundwater. The decision on which source of water to use may ultimately be based on a combination of availability, infrastructure, permitting, and water quality and chemistry.

Some of the activities listed above could affect surface water quality. These include the use of high-pressure sprays of water during decontamination, dust suppression, and equipment cooling, and the discharge of various process waters. For decontamination, BMPs would need to be followed to manage the sprayed water. Both the decontamination water and the process waters would need to be discharged in accordance with NPDES permit requirements.

The early stages of decommissioning and dismantling may involve a temporary, slight increase in the size of the overall workforce (NRC 2002a). The amount of sanitary system discharge would therefore increase slightly. Depending on when any onsite wastewater treatment plant, onsite septic system, or municipal sewage system connection would stop operating, temporary portable toilet facilities might be used for the decommissioning workforce. The number and capacity of such facilities would depend on the size of the workforce, which could vary during different phases of the decommissioning process.

In the decommissioning GEIS (NRC 2002a), evaluations focused on water use and water quality. The following activities were identified as having the potential to affect surface water:

- Cooling water systems,
- Discharge from dewatering systems, and
- Stormwater management and erosion control.

Surface water would remain the largest source of water used during decommissioning; it would be used to cool the spent fuel. However, this usage, as well as makeup water requirements, would be significantly smaller than during reactor cooling at an operating power plant. Demand for spent fuel cooling water would decrease over time as the fuel aged. Other activities listed above would also require amounts of water that would be low compared to cooling and makeup water requirements.

Dewatering systems would continue to discharge to surface water. The effect on surface water quality would be unchanged from the effect during the operational phase.

Stormwater management and erosion control would continue to be maintained during decommissioning to reduce the potential for effects on surface water quality, especially turbidity. Soil erosion can be minimized through BMPs, as discussed in Section 4.4.1. Chemical spills during decommissioning also have the potential to affect surface water quality. However, BMPs for handling fuels and other chemicals used in the operational phase should continue to be in place.

The natural variability in the climate, especially precipitation, has the potential to influence the availability of surface water. However, because it seems that there have not been any surface water availability problems at operating power plants with relatively higher water requirements for reactor cooling, severe drought is not expected to affect decommissioning.

In the decommissioning GEIS (NRC 2002a), the NRC concluded that the impacts on water use and water quality from decommissioning would be SMALL for all plants. The effect of license renewal on the water quality impacts from decommissioning was considered a Category 1 issue in the 1996 GEIS. On the basis of a review of current information, these conclusions are considered valid for surface water. An additional 20 years of operation during the license renewal term would not change the magnitude of these impacts.

The activities listed above include some that may affect groundwater quality through the infiltration of water used for various purposes (e.g., cooling of cutting equipment, decontamination spray, and dust suppression). Best management practices are expected to be employed as appropriate to collect and manage these waters.

In the decommissioning GEIS (NRC 2002a), evaluations focused on water use and water quality. The following activities were identified as having the potential to affect groundwater:

- Potable water from wells,
- Dewatering systems, and
- Leachate from rubble.

Potable water would be required during decommissioning. The typical source for this supply is onsite groundwater, though surface water or an offsite municipal source of surface water or groundwater may be used at some sites. The early stages of decommissioning and dismantling may involve a temporary, slight increase in the size of the workforce, and a proportional increase in the need for potable water may occur (NRC 2002a).

Dewatering is expected to continue as it does during the operational phase, without increased drawdown at nearby onsite or offsite wells.

The NRC proposed that groundwater chemistry may change as rainwater infiltrates through rubble. The increased pH could promote the subsurface transport of radionuclides and metals. However, this effect is expected to occur only over a short distance as a function of the buffering capacity of soil (NRC 2002a). Offsite transport of groundwater contaminants is not expected.

In the decommissioning GEIS (NRC 2002a), the NRC concluded that the impacts on water use and water quality from decommissioning would be SMALL for all plants. The effect of license renewal on the water quality impacts from decommissioning was considered a Category 1 issue in the 1996 GEIS. On the basis of a review of current information, these conclusions are considered valid for groundwater. An additional 20 years of operation during the license renewal term would not change the magnitude of these impacts.

Ecological Resources

The termination of nuclear power plant operations would reduce some impacts and eliminate others. Impacts from systems that continue operating to support other units (i.e., where the license term for each unit does not end at the same time) on the plant site may continue to affect terrestrial or aquatic biota, but at a reduced level of impact.

Impacting factors that would cease following reactor shutdown would include cooling tower drift, cooling system maintenance and effluent discharges, and atmospheric emissions of radionuclides. If there are other reactor units at the power plant and they continue to operate, these factors would be reduced, but not eliminated. A number of impacting factors would continue to affect terrestrial resources, however. Until removed during decommissioning, cooling towers and transmission lines would continue to be collision hazards for birds.

Impacting factors on aquatic resources that are expected to stop or decrease after reactor shutdown include the withdrawal of water for cooling, discharge of heated cooling water, dredging activities, and onsite construction activities. Cooling demands of a reactor in cold shutdown will be greatly reduced, as will be the rate of water withdrawal to maintain appropriate water volumes and chemical quality in the cooling system. However, water withdrawal may not be completely eliminated unless or until fuel assemblies are removed from the reactor core. Also, water withdrawal rates will continue unchanged to support other units and facilities onsite that remain operational. Nevertheless, the impingement and entrainment of aquatic organisms would substantially decrease after plant operations cease, and the potential for impacts on aquatic communities from these factors would be reduced. In general, the termination of entrainment and impingement would have positive effects on affected organisms.

As identified in Section 4.6.1.2, the discharge of heated cooling water during operations has the potential to affect aquatic resources by altering the thermal regimes to which aquatic organisms are exposed, lowering the level of dissolved oxygen, and promoting gas supersaturation. Because the plant would discharge significantly smaller volumes of heated water after operations cease, the NRC anticipates that the plant's influence on the thermal conditions in the receiving waters would be greatly reduced.

During the years of plant operations, it is likely that an aquatic community that was acclimated to warmer temperatures and biocides would have developed within the mixing zone. Some aquatic organisms may have become established in the mixing zone because of the warmer environment, and these organisms likely would be adversely affected as the water temperature cooled and the original conditions were restored within the body of water. Organisms susceptible to cold shock could be affected, depending on the timing and rate of change in water temperatures. Such effects, which occur primarily during winter months, would occur only during the initial period after the plant ceases operations, and they could be minimized by initiating reactor shutdown during seasons when cold shock would be less likely to occur and by gradually reducing inputs of heated effluent to the system. As a consequence of the return to a more natural thermal regime, it is anticipated that the composition of the aquatic organisms in that area would return to a composition similar to that in the surrounding areas of the receiving waters. Recovery of an aquatic community to the normal background composition is a process of variable duration that depends on the mobility of the organisms, sources of colonists, rate of growth and maturation of the species, and other factors (Cairns 1990). Populations of some invasive species, such as the water hyacinth (*Hydrilla verticillata*) that proliferates at the North Anna plant in Virginia as a result of the elevated temperature of discharges, may decline as water temperatures in the receiving body of water fall.

The impacts from the termination of nuclear power plant operations on a cooling pond depend largely on whether the pond continues to exist. For cooling ponds that are maintained during plant operation by pumping water from another water body, the ponds would likely revert to a terrestrial system after pumping stopped. Even if ponds are maintained by natural flow, water may no longer be impounded. Restoration of these previously impounded areas may be necessary to minimize adverse ecological impacts associated with the exposure of previously inundated substrates. If the ponds continued to exist, the nuclear plant's thermal effects on them would cease. Cessation of the heated effluent would change the composition and dynamics of the pond community until it resembled that of other ponds in the region not used for cooling.

Because there would no longer be a need to withdraw or discharge cooling water, it is also anticipated that dredging would no longer be needed in the vicinity of cooling water structures. Therefore, the potential for dredging to affect aquatic biota would also be eliminated, unless the cooling water system was still needed to cool other electrical generating systems. As described in Section 4.6.1.2, gas supersaturation has the potential to occur within the mixing zone of some power plants. Even though such effects have been reduced with mitigation measures, such as the use of diffusers in the discharge area, the potential for gas supersaturation and subsequent effects on biota as a result of plant operations would be eliminated or decrease from the potential under the proposed action. Activities that result in ground disturbance (e.g., new construction, maintenance of some areas) may also cease or decrease at power plants that are shut down as a consequence of the no-action alternative, but there would be some level of maintenance needed until the plant was decommissioned. This would result in a decrease or the cessation of potential effects on aquatic resources from the direct disturbance of aquatic habitats and the sedimentation that could occur as a result of ground disturbance in adjacent areas.

Because some structures may be left in place until decommissioning has been completed or longer, there is a potential for some effects on aquatic resources to continue regardless of whether or not the reactor at a plant is operating. For example, dams and associated reservoirs constructed to maintain supplies of water for operational needs may continue to prevent migration of anadromous fish unless the structures are removed. In addition, maintenance activities would continue along the transmission line ROWs regardless of whether the plant is operating or not.

At coastal plants, the termination of nuclear plant operations could have a beneficial impact on the Federally listed loggerhead sea turtle (threatened), green sea turtle (*Chelonia mydas*, threatened), leatherback sea turtle (endangered), hawksbill sea turtle (endangered), and Kemp's ridley sea turtle (endangered), which have been impinged at several nuclear power plants (e.g., St. Lucie and Oyster Creek). Similarly, potential benefits to the Federally endangered West Indian manatee and pinnipeds, protected under the Marine Mammal Protection Act, could occur. For example, the West Indian manatee has been impinged at St. Lucie, and incidental takes of harbor seals, gray seals, harp seals, and hooded seals occur at the Seabrook plant. Elimination of high-temperature discharges at plants in Florida may reduce habitat suitability for the West Indian manatee, particularly during winter. However, the West Indian manatee occupies other habitats in Florida that do not have artificially elevated temperatures, and it uses a number of thermal discharges from fossil fuel plants along both coasts of Florida (Laist and Reynolds 2005). Potential impingement and entrainment losses of special status fish species could also decrease. Reactor shutdown could also decrease impacts on EFH, although only minimal adverse effects have been identified for the operating plants for which EFH assessments have been prepared (e.g., Pilgrim, Vermont Yankee, and Oyster Creek plants).

The NRC evaluated the potential impacts of decommissioning on ecological resources in the decommissioning GEIS (NRC 2002a). The conclusions of that evaluation are summarized here, but the focus of the present evaluation is on the incremental effects that would result from deferring decommissioning to a later date as a result of renewing the license for plant operations. In the 1996 GEIS, the NRC concluded that the ecological impacts of decommissioning activities would be the same with or without license renewal and was designated a Category 1 issue.

The NRC (2002a) evaluated potential impacts on terrestrial ecological resources during the decommissioning process via both direct and indirect disturbance of native plant or animal communities in the vicinity of the plant site. In most cases, the impacting factors and the potential impacts from decommissioning activities are similar to impacts that could occur as a consequence of continued operations and refurbishment activities at operating facilities. Direct impacts of decommissioning on terrestrial ecological resources could result from activities such as the clearing of native vegetation or filling of a wetland. Indirect impacts could result from erosion, dust, or noise. In most cases, land disturbances during decommissioning would result in relatively short-term impacts, and the land would either recover naturally or would be landscaped appropriately for an alternative use after completion of decommissioning (NRC 2002a). The NRC determined that impacts on terrestrial resources from dust generation, noise, surface erosion and runoff, and migratory bird collisions associated with decommissioning would be minor and would continue only until decommissioning activities were completed (NRC 2002a). The effects of such impacts could be minimized by using standard best management practices.

At most commercial nuclear facilities, there is a relatively distinct operational area where most or all site activities occur. This operational area usually includes all areas within the protected area fence; the intake, discharge, cooling, and other associated structures; and adjacent paved, graveled, and maintained landscaped areas. The operational area may include the entire area disturbed during facility construction, but it is often considerably smaller. In most cases, the amount of land required to support the decommissioning process is relatively small and is a small portion of the overall plant site. Usually, the areas disturbed or used to support decommissioning are within the operational areas of the site and are also within the protected area. Decommissioning activities conducted within the operational areas are not expected to have a detectable impact on important terrestrial resources (NRC 2002a). However, it is expected that some sites will require the reconstruction or installation of new transportation links, such as railroad spurs, road upgrades, or barge slips, for the completion of decommissioning. The NRC (2002a) concluded that for facilities at which the decommissioning activities would be limited to existing operational areas, the potential impacts on terrestrial ecology would be SMALL. It was further concluded that if habitat disturbance beyond the operational areas is anticipated, the impact on terrestrial resources could be SMALL, MODERATE, or LARGE and would have to be determined through a site-specific analysis.

In most cases, the impacting factors and the potential impacts on aquatic resources from decommissioning activities are similar in nature to impacts that could occur as a consequence of refurbishment activities for operating facilities. Direct impacts of decommissioning on aquatic resources could result from activities, such as removing shoreline or in-water structures (i.e., the intake or discharge facilities); dredging a stream, river, or ocean bottom; or depositing fill in a stream or bay. Indirect impacts could result from effects such as runoff and sedimentation from disturbed upland areas (NRC 2002a). During decommissioning, aquatic habitats at the plant site might also be disturbed in order to construct support facilities, such as a dock for barges or a bridge over a stream or some other body of water. In addition, aquatic environments away from the plant site could be disturbed during the upgrading or installation of new transportation systems (e.g., a new rail line to support the removal of large components) or during the installation or modification of transmission lines. In most cases, aquatic habitat disturbances from decommissioning would result in relatively short-term impacts on small areas, and either the affected aquatic habitats would recover naturally or the impacts could be mitigated

(NRC 2002a). Typically, these impacts would be temporary and would not detectably alter or destabilize important ecological attributes (NRC 2002a).

If decommissioning did not include removal of shoreline or in-water structures and if all decommissioning activities were confined to the plant operational areas, impacts from decommissioning on aquatic resources would be expected to be minor and would result primarily from increased sediment from physical alterations of the site. In such cases, it is expected that the impact on aquatic resources would be nondetectable, nondestabilizing, and easily mitigated (NRC 2002a). Greater impacts on aquatic resources could occur if decommissioning entailed the removal of structures from the shoreline or in-water environment, removal of contaminated soil in or near an aquatic environment, or dredging and significant modification of barge loading facilities (NRC 2002a).

Permits for discharge to the aquatic environment during operations are almost always for discharge amounts that are greater than planned or realized during decommissioning. In almost all cases examined, licensees expect to restrict activities to previously disturbed areas and operate within the limits of operational permits (NRC 2002a). The NRC (2002a) concluded that for facilities at which the decommissioning activities would be limited to existing operational areas, the potential impacts on aquatic resources would be SMALL. It further concluded that if habitat disturbance beyond the operational areas was anticipated, the impacts on aquatic resources could be SMALL, MODERATE, or LARGE and would have to be determined through site-specific analysis.

In most cases, the impacting factors and the potential impacts on threatened or endangered species (including other special status species or habitats) from decommissioning activities are similar in nature to impacts that could occur as a consequence of refurbishment activities for operating facilities. These species could be affected during the decommissioning process, either through direct effects or through disturbances of habitats on which the species rely for food or shelter. If a nuclear plant ceased operations for an extended period of time, the situation could allow the establishment of onsite populations of protected species that could be adversely affected by subsequent facility decommissioning at the end of the storage period (NRC 2002a).

The greatest potential for impacts from decommissioning on protected species is associated with physical alteration or dismantlement of the facilities, landscape, or aquatic environment. The impacts of decommissioning could result from activities similar to those described for terrestrial and aquatic resources. The NRC (2002a) concluded that the potential impacts on threatened and endangered species may be SMALL, MODERATE, or LARGE and that the adverse impacts and associated significance of the impacts must be determined on a site-specific basis.

The impacts of decommissioning on ecological resources depend primarily on the types of decommissioning activities that are conducted and whether those activities occur inside or outside the existing operational area. Although many of the activities that could affect ecological resources during decommissioning are the same as the activities that occur during the normal operation of a nuclear power plant, the length of time that operations have been ongoing will not change the level of impacts associated with decommissioning. Therefore, deferring decommissioning by renewing a plant's license would have the same impacts on ecological resources, if any, as would occur as a result of starting decommissioning sooner. The impact from the termination of plant operations and decommissioning on ecological resources attributable to license renewal would be SMALL for all nuclear plants.

Historic and Cultural Resources

The termination of nuclear plant operations would not affect historic or cultural resources.

The NRC conducted an analysis of the potential effects of decommissioning on historic and archaeological (cultural) resources and found that the potential onsite impacts at sites where the disturbance of lands would not go beyond the operational areas would be SMALL (NRC 2002a). The continued operation of a plant under a renewed license would not be expected to alter this conclusion. Similar activities are expected to continue before and after license renewal. The majority of impacts on historic and cultural resources would have occurred during the original construction of the plant. Continued use has the potential to affect these resources, as discussed in Section 4.7.1. There is nothing inherent in using a plant for a longer time that would increase or decrease the impact on these resources from decommissioning. Adherence to procedures that take into account the impact on historic and cultural resources would mitigate any additional impacts.

Delaying decommissioning is not expected to have any effect on historic and cultural resources within a transmission line ROW. Impacts on historic and cultural resources would likely have occurred during initial construction. On the basis of these considerations, the effect of license renewal on the impacts from the termination of plant operations and decommissioning would be SMALL for all nuclear plant sites.

Socioeconomics

Terminating nuclear plant operations would have a noticeable impact on socioeconomic conditions in the region around the nuclear power plant. There would be immediate socioeconomic impacts from the loss of jobs (some, though not all, employees would begin to leave after power plant shutdown); and tax revenues generated by plant operations would also be reduced. Depending on the tax formula used to determine property tax payments, the amount of money paid to local taxing jurisdictions may be reduced. However, property tax payments would continue. Demand for services and housing would likely decline. Indirect employment and income created as a result of nuclear power plant operations would also be reduced.

Loss of employment at nuclear plants located in rural communities would likely mean workers and their families would leave in search of jobs elsewhere. The decrease in the demand for housing and the increase in available housing would depress rural housing market prices. Conversely, at nuclear power plants located in semi-urban areas, workers and their families may remain because of greater opportunities for new employment.

The impacts from the loss or reduction of tax revenue due to the termination of plant operations on community and public education services could range from SMALL to LARGE. Nuclear power plants generally provide a significant amount of tax revenue to local communities and public school districts. The loss or reduction in tax revenues from the nuclear plant could mean the reduction and/or the elimination of some community and public educational services. Traffic congestion caused by commuting workers and truck deliveries during plant operations would also be reduced. License renewal would only delay the timing of these impacts. Therefore, the incremental effect of license renewal would be SMALL for all nuclear plants. See Appendix J to NUREG-0586, Supplement 1 (NRC 2002a), for a discussion of the potential socioeconomic impacts of plant decommissioning.

Human Health

With the termination of plant operations, there would be a period between the time when a reactor stopped operating and when the decommissioning of the plant began that could range from months to years. During that period, the reactor would be placed in a cold shutdown condition and maintained. The fuel might be removed from the core and put in the spent fuel storage pool. Workers would continue to receive radiation exposure during work activities related to placing the reactor in shutdown status. Radioactive gaseous and liquid effluent releases to the environment would continue, although at a lower level, that would result in radiation exposure to the public. The regulatory requirements and dose limits during this period for workers and the public are the same as those for operating reactors (see Section 3.9.1.1). The radiological impacts on workers and members of the public during this time period would be less than those during current operations and those expected during decommissioning.

Public exposure to EMFs would decrease after transmission lines were de-energized. Power would still be provided to the site, and workers might be exposed to EMFs during this period. It is expected that the impacts from EMFs during this period would be less than the impacts from current operations.

Because reactor shutdown would result in the cessation or reduction of cooling system operations, the public's exposure to chemical and microbiological hazards associated with these operations would be reduced. The plant workers might be exposed to chemical, microbiological, and other hazards during this period, but the hazards would be SMALL and bounded by the hazards either during operations or decommissioning.

The remainder of this section evaluates the effects of license renewal on the human health impacts from the termination of nuclear power plant operations and decommissioning. The issues considered here include the impacts from radiological exposure and risk, chemical hazards, microbiological hazards, physical occupational hazards, and electrical hazards. Work during decommissioning activities is generally done according to an environmental safety and health plan that serves as a guidebook for anticipating hazards and preventing any injury or harm. In the 1996 GEIS, the NRC considered the effect of license renewal on only the radiation dose impacts of decommissioning.

The human health impacts from physical, chemical, and microbiological hazards during the termination of plant operations and decommissioning would be SMALL for all plants. The effect of license renewal on the impact from terminating plant operations and decommissioning on human health also would be SMALL at all plants. Doses to the public would be well below applicable regulatory standards, regardless of which decommissioning option was used. Collective occupational doses would increase no more than 0.1 person-rem, attributable to the buildup of long-lived radionuclides during the license renewal term, but the individual worker doses would be well below the existing dose limits. On the basis of these considerations, the NRC concludes that the effect of license renewal on the impact from decommissioning on human health would be SMALL for all nuclear plants.

Radiological Exposure

During decommissioning activities, workers are exposed to radioactive materials that are present in the reactor and support facilities, and members of the public may be exposed to radioactive materials that are released to the environment. The regulatory requirements and dose limits during decommissioning are the same as those for operating reactors (see Section 3.9.1.1). Many activities during decommissioning are similar to the activities that occur during normal maintenance outages, such as decontamination of piping and surfaces; removal of piping, pumps, and valves; and removal of heat exchangers. Some of the activities, such as removal of the reactor vessel or demolition of facilities, are unique to decommissioning. The decommissioning GEIS (NRC 2002a) evaluated the potential radiological impacts of decommissioning activities for both PWRs and BWRs. Public and occupational radiation exposures from decommissioning activities were evaluated on the basis of information derived from recent decommissioning experience.

Radiation Exposures to Plant Workers

Both the 1996 GEIS and the decommissioning GEIS provide estimated collective occupational radiation doses for decommissioning PWRs and BWRs for the three decommissioning options: DECON, ENTOMB, and SAFSTOR. The decommissioning GEIS also includes the estimated collective occupational radiation dose for plants that are currently in the decommissioning process. The DECON method had the highest dose, followed by ENTOMB and then SAFSTOR. According to the decommissioning GEIS, occupational doses to individual workers during decommissioning activities are estimated to average approximately 5 percent of the regulatory dose limits established in 10 CFR Part 20 and to be similar to, or lower than, the doses experienced by workers in operating facilities.

A 20-year extension in operations would increase the occupational doses from long-lived radionuclides such as niobium-94, but these increases would not be significant for the DECON option because short-lived radionuclides (primarily cobalt-60) are the principal contributor to the occupational dose (NRC 1996). For the SAFSTOR option, an additional 20 years of operations would increase the amount of niobium-94 by 50 percent. The contribution of niobium-94 to the collective dose for this decommissioning option for 40 years of plant operation is less than 0.2 person-rem; therefore, the increase in dose during decommissioning after 20 additional years of operations would be less than 0.1 person-rem. Total worker doses may increase, but individual worker doses would be well below the regulatory limits. The NRC concluded that the impact of an additional 20 years of plant operation on the radiological doses to workers would be of SMALL significance for all nuclear plants.

Radiation Exposures to the Public

According to the 1996 GEIS, the radiation dose to the public during decommissioning would result primarily from waste shipment for both PWRs and BWRs, and the dose would be almost exclusively attributable to the shipment of short-lived radionuclides, mainly cobalt-60. During decommissioning, the estimated increased risk of fatal cancer to an average member of the public would be much less than 1×10^{-6} (NRC 2002a). If a plant operated an additional 20 years, only the quantities of long-lived radionuclides would increase, and only the dose caused by the long-lived radionuclides would increase. As discussed in the 1996 GEIS, the dose to the public from long-lived radionuclides after 40 years of plant operation is expected to be negligible, and the increase in quantities of long-lived radionuclides after an additional 20 years would result in a negligible dose (less than 0.1 person-rem). Accordingly, the NRC concluded that the contribution of license renewal to radiological impacts to the public from decontamination would be of SMALL significance at all nuclear plants.

Chemical Hazards

Decommissioning involves many activities that expose workers to chemical hazards, including paints, asbestos, lead, polychlorobiphenyls, mercury, quartz, and other hazardous materials in building materials. During decommissioning, workers may also be exposed to fumes (that often include lead and arsenic) and smoke from flame cutting and welding. According to the decommissioning GEIS, with proper planning, workplace design, and engineering controls, supplemented by the use of personal protective equipment and administrative solutions, the impact of chemical hazards on workers would be of SMALL significance at all nuclear plants. A 20-year delay caused by license renewal would not change the projected human health impact from chemical hazards because (1) there would not be any more hazardous chemicals present, (2) the workers would still would have a proper work plan, and (3) all required controls would be in place.

Microbiological Hazards

During decommissioning, workers may be exposed to molds and other biological organisms that grow in and on buildings. Proven industrial hygiene principles mitigate the risk of developing diseases from these organisms. According to the decommissioning GEIS, if a thorough inspection of the facility is conducted and proper cleansing and personal protective equipment are used when biological agents are identified, the impacts of biological agents on workers would be SMALL. A 20-year license renewal would not change the microbiological hazards associated with decommissioning at any nuclear plant because the workers would still be using proper cleansing and personal protective equipment when biological hazards were identified.

Electromagnetic Fields

Operating transmission lines produce an EMF. When a nuclear power plant ceases to operate, no electricity is transmitted. Therefore, the public's exposure to EMF could decrease unless the power that was no longer being generated at the plant was replaced by new power generation. Power would still be provided to the site, and workers might be exposed to EMF during decommissioning. It is expected that the impacts during decommissioning would be bounded by the impacts from current operations. The EMF impact associated with decommissioning after a 20-year license renewal term would not differ from that without renewal.

Other Hazards

The major sources of physical occupational hazards during decommissioning involve the operation and use of construction and transportation equipment. Workers may be exposed to extreme temperatures while working outdoors. They may operate cranes near power lines, dig near buried cables, and encounter electrical hazards. During demolition or dismantlement, the workers may use cutting torches, which can start fires. It is expected that all of the activities would be anticipated in advance, and that proper precautions would be taken to minimize any adverse impacts. A 20-year delay in decommissioning caused by license renewal would have no effect on the projected human health impact from other hazards, because the workers would have the proper work planning, workplace design, and controls in place. Moreover, the conditions would not be more hazardous after an additional 20 years.

Accidents during the Termination of Nuclear Plant Operations and Decommissioning

The impacts of postulated accidents during the license renewal term are discussed in Section 4.9.1.2. The general characteristics, including the source terms, of postulated accidents are expected to be similar after reactor shutdown; therefore, the consequences would also be expected to be similar. Because of the enhanced aging management activities and extended life of certain systems, structures, and components, there may be small differences in the probabilities of occurrence of these accidents after reactor shutdown. These differences, however, are not expected to be significant, and the risks of accidents after reactor shutdown would be expected to be similar to or less than the risks discussed in Section 4.9.1.2 for the proposed action.

The impacts associated with accidents that can occur during the decontamination and decommissioning of nuclear power plants were analyzed in the Decommissioning GEIS (NRC 2002a). The radiological impacts of accidents were discussed in Section 4.3.9 of the same document, and nonradiological impacts were discussed in Section 4.3.10. Radiological accidents that were considered in the analysis included both those that relate to onsite storage and handling of spent nuclear fuel and those that are unrelated to spent nuclear fuel. The non-fuel-related accidents centered on decontamination, dismantlement, and storage-type accidents. The accidents included fires, handling accidents, explosions (e.g., explosion of liquid propane gas tanks), and accidental releases of liquid radioactive wastes from storage tanks.

Nonradiological accidents were considered under occupational issues and included physical, chemical, ergonomic, and biological hazards. The category of physical hazards included potential injuries or deaths resulting from the operation and use of construction and transportation equipment. Electrical hazards, including the potential for electrocution, were also considered. The potential exposure of workers to chemical and biological agents was considered under both normal operations and accidents. Ergonomic conditions were evaluated from the point of view of ergonomic stress such as discomfort and fatigue affecting the workers' performance and safety.

The NRC made the following conclusions regarding radiological accidents associated with decommissioning on the basis of the evaluations conducted for the decommissioning GEIS (NRC 2002a):

> The NRC has considered available information, including comments received on the draft of Supplement 1 of NUREG-0586, concerning the potential impacts of non-spent-fuel-related radiological accidents resulting from decommissioning. This information indicates that, with the mitigation procedures in place, the impacts of radiological accidents are neither detectable nor destabilizing. Therefore, the NRC makes the generic conclusion that the impacts of non-spent-fuel-related radiological accidents are SMALL. The NRC has considered mitigation and concludes that no additional measures are likely to be sufficiently beneficial to be warranted.
>
> The NRC has considered available information, including comments received on the draft of Supplement 1 of NUREG-0586, on the potential impacts of spent-fuel-related radiological accidents resulting from decommissioning. The NRC concludes that the impacts of spent fuel storage during the license renewal term are SMALL. The NRC concludes that additional mitigation measures are not likely to be sufficiently beneficial to be warranted.

The conclusion regarding the occupational issues, which included nonradiological accidents, was as follows:

> The NRC has considered available information, including comments received on the draft of Supplement 1 of NUREG-0586, on the potential impacts of decommissioning activities on occupational issues. This information indicates that the impacts on occupational issues are not detectable or destabilizing. Therefore, the NRC makes a generic conclusion that, for all plants, the potential impacts on occupational issues are SMALL. The NRC has considered mitigation measures and concludes that no additional mitigation measures are likely to be sufficiently beneficial to be warranted.

License renewal would merely delay when accidents associated with the termination of nuclear power plant operations and decommissioning could occur and would not significantly affect their probability or consequence.

Environmental Justice

Termination of power plant operations and the resulting loss of jobs, income, and tax revenue could have a disproportionate effect on minority and low-income populations. The loss of tax revenue, for example, could reduce the availability or eliminate some of the community services that low-income and minority populations may depend on. This situation could be offset with the construction and operation of replacement power generating facilities and the creation of other employment opportunities at or near the nuclear plant site.

Decontamination and decommissioning activities could affect air and water quality in the area around each nuclear plant site. This could cause health and other environmental impacts in minority and low-income populations, if present. Population groups with particular resource dependencies or practices (e.g., subsistence agriculture, hunting, fishing) could also be disproportionately affected.

Environmental impacts associated with decommissioning activities at each nuclear plant and the extent to which minority and low-income populations could be affected, are discussed in the decommissioning GEIS (NRC 2002a). License renewal would only delay, but not alter the impact of decommissioning on minority and low-income populations around each nuclear plant.

Waste Management and Pollution Prevention

After termination of nuclear plant operations, there would be a period before the beginning of decommissioning when the reactor would be placed in a cold shutdown condition and maintained. The fuel might be removed from the core and put in the spent fuel storage pool. There might also be activities related to placing the reactor in shutdown status that could result in the generation of some waste. The types of waste generated during this period would be the same as the types of waste generated during operations and decommissioning. The quantities of waste generated would be smaller than the quantities generated during either operations or decommissioning. The impacts associated with the management of LLW, hazardous waste, mixed waste, and nonradioactive and nonhazardous waste during operations and decommissioning would be SMALL. These impacts would also be SMALL when the reactor was in shutdown status pending decommissioning. All pollution prevention and waste minimization measures instituted during operations would likely continue to be used to minimize releases to the environment and minimize the quantities of waste generated. As discussed in Section 4.11.1.2, the NRC has determined that spent nuclear fuel could be stored onsite safely and with a minimal environmental impact during the license renewal term and the NRC is working on a separate rulemaking and EIS for the Waste Confidence Decision and Rule to address the period after the cessation of reactor operations.

The decommissioning process, by its very nature, generates wastes. The wastes generated are shipped offsite, where they are permanently disposed of, or stored onsite for a certain period or indefinitely. Under the three decommissioning options analyzed in the decommissioning GEIS (NRC 2002a), the DECON process would generate the most waste. In this process, the equipment, structures, and portions of the facility and site that contain radioactive contaminants are removed and decontaminated to a level that permits termination of the license after cessation of operations. In the SAFSTOR process or ENTOMB process, the materials are left onsite temporarily or permanently, respectively.

The impacts from decommissioning that result in the generation of wastes and their onsite management until they are loaded onto vehicles to be shipped offsite are addressed under other disciplines discussed in Section 4.12.2.1. This section addresses the impacts from transporting the wastes to disposal facilities and from their disposal. If there are interim locations offsite where wastes undergo treatment before being sent to a disposal facility, they are also discussed here.

The types of wastes generated during decommissioning would include LLW, mixed waste, hazardous waste, and nonradioactive, nonhazardous waste (see Section 3.11 for waste type definitions). No spent fuel, HLW, or transuranic waste would be generated during decommissioning because spent fuel would have been removed from the reactor and stored in either the reactor's spent fuel pool or in an ISFSI before the start of decommissioning.

It is expected that most of the waste generated during decommissioning would be LLW and nonradioactive, nonhazardous waste. There would be small quantities of mixed waste (mostly paints, waste oils, solvents, and metals such as lead or cadmium) that would be managed per the requirements of RCRA for its hazardous component and the Atomic Energy Act (AEA) for its radioactive component, as described in Section 3.11.3. The quantities of hazardous waste that would be generated would also be small and would mainly consist of paints, solvents, and batteries. Some of the materials used to decontaminate surfaces could also end up being classified as mixed waste. Both mixed wastes and hazardous wastes could be sent to an authorized waste treatment center for incineration or some other form of treatment before being sent to a disposal facility authorized to accept such waste. All of these activities would be conducted according to permits and requirements established under RCRA. The nonradioactive, nonhazardous waste, consisting mainly of rubble and debris, would be sent to a local landfill.

The impacts associated with transporting equipment and materials (radiological and nonradiological) offsite during decommissioning are analyzed in Section 4.3.17 of the decommissioning GEIS (NRC 2002a). The materials transported offsite would include all wastes generated onsite. Radiological impacts would include exposure of transportation workers and the general public along the transportation routes. Nonradiological impacts would include increased traffic volume, additional wear and tear on roadways, and potential traffic accidents. It was concluded that the transportation impacts would not be destabilizing. Therefore, the NRC made the generic conclusion that for all plants, the potential transportation impacts would be SMALL.

There might be small differences in the quantities and characteristics of the waste that would be generated during decommissioning after the license renewal term and the waste that would be generated after the original license period. If the plant license was not renewed, the reactor could be decommissioned at the end of the current license term, whereas if the license was renewed, the decommissioning would take place approximately 20 years later. Additional waste might accumulate at the site, or the radioactivity of some components undergoing decommissioning might be slightly higher at the end of the license renewal term. For example, if there were any refurbishment activities during the license renewal term that resulted in equipment (e.g., steam generators) being taken out of service and subsequently stored onsite awaiting disposition during decommissioning, the amounts of certain types of waste (e.g., LLW) generated from decommissioning under the proposed action would be more than the amounts generated during the original license period. Because of the differences in timing, some of the materials in and around the core of the reactor might have slightly higher radioactivity under the proposed action as a result of a buildup in long-lived radionuclides. This situation would mainly affect the amount of greater-than-Class C LLW at the site. Assuming that the spent nuclear fuel continued to be stored onsite during the license renewal term, there would also be more spent fuel to manage. Similarly, if certain LLW classes (e.g., Class A, B, and C wastes) had to be stored onsite for long periods (for the reasons discussed in Section 4.11.1), the amounts of those wastes that would have to be addressed during decommissioning might be larger after the license renewal term. However, because all radioactive waste must be handled in accordance with NRC regulations, it is not expected that these differences would significantly alter the practices employed to manage the wastes or the impacts associated with managing the wastes generated during decommissioning.

The decommissioning activities would be designed and implemented in ways to prevent pollution and minimize the amount of waste generated. All the methods mentioned in Section 3.11.5, including source reduction and recycling of materials either onsite or offsite, would be used. Under source reduction, the licensees would use decontaminating agents and technologies that would generate less waste, particularly mixed and hazardous waste. They would also implement procedures and practices that would be aimed at preventing or minimizing gaseous and liquid releases to the environment and the quantities of waste generated.

The quantity of LLW that would be generated from the decommissioning of a model 1,000-MWe power plant is included in the quantities of LLW reported on in Section 4.12.1.1. The quantities of mixed waste and hazardous waste that would be generated from decommissioning of nuclear power plants would be relatively small and managed in a way that would protect human health and the environment to meet RCRA requirements. Clean wastes (wastes that are neither radioactive nor hazardous) would be disposed of at a local permitted landfill. The transportation of wastes from a model LWR is also reported on in Section 4.12.1.1. The offsite transportation of equipment and wastes from a power plant undergoing decommissioning was also analyzed in the decommissioning GEIS (NRC 2002a), and the impact was found to be SMALL. On the basis of these considerations, the effect of license renewal would be SMALL for all plants.

4.12.2.2 Termination of Power Plant Operations and Decommissioning of Replacement Power Plants

Fossil Energy Alternatives

The environmental consequences from the termination of power plant operations and the decommissioning a fossil fuel energy facility are dependent on the decommissioning plan. It is reasonable to expect that decommissioning plans would include the following elements and requirements:

- Removal of all unneeded structures and facilities to at least 3 ft (1 m) below grade (in order to provide an adequate root zone for site revegetation).
- Removal of all coal, all coal combustion waste, and all flue gas desulfurization (FGD) sludge and/or byproducts.
- Removal of water intake and discharge structures.
- Dismantlement and/or removal of all ancillary facilities, including rail spurs, coal handling and preparation facilities, cooling towers, natural gas pipelines, onsite wastewater treatment facilities, and access roads.
- Removal of all surface water intake and discharge structures.
- Removal of all accumulated sludge, and closure and removal of all surface water impoundments.
- Proper closure of all onsite groundwater wells.
- An aggressive recycling program for removed equipment and dismantled building components; materials awaiting recycling would be stored at an offsite facility.
- Minimal delay times for removed materials and equipment at temporary laydown areas.
- Expeditious disposal of solid and hazardous wastes at approved facilities; as necessary, remediation of waste handling and storage areas.
- Cleanup and remediation of all incidental spills and leaks.
- Successful execution of an approved revegetation plan for the site.

- Other actions as necessary to ensure restoration of the site to a condition equivalent in character and value to the greenfield or brownfield site on which the facility was first constructed.

Assuming that decommissioning occurs according to a decommissioning plan as described above, environmental consequences (at either a greenfield site or a brownfield site) would include:

- Short-term impacts on air quality and noise from the operation of vehicles and equipment used to deconstruct structures and facilities and the increased number of workforce vehicles traveling to and from the site; impacts include release of criteria pollutants and generation of fugitive dust and noise (including from the possible use of explosives to deconstruct buildings or structures); impacts would be similar to, but of shorter duration than, those experienced during facility construction.

- Short-term impacts on land use and visual resources due to increased human activities on the site and establishment of temporary holding areas for dismantled components and other deconstruction debris (some of which may be at offsite locations—e.g., at rail headers).

- Short-term increase in local traffic as a result of increases in workforce personnel onsite and truck and rail traffic bringing deconstruction equipment to the site and transporting dismantled structures, removed equipment, and deconstruction debris.

- Long-term reestablishment of vegetation and wildlife communities.

- Restoration of visual values through removal of manmade structures and restoration of native vegetative and wildlife communities.

- Short-term increase in local economic activity with the increased dismantlement workforce and other related functions such as transportation, followed by a longer-term downturn of local economy due to loss of jobs of operational personnel.

- Reestablishment of original land use opportunities.

- Elimination of health and safety impacts on operating personnel and the general public from routine operation of the facility and as a result of accidents involving the facility; short-term increase in health and safety risk to decommissioning workforce due to complex and concentrated industrial activities, and short-term increase in risk of transportation-related accidents, due to increased traffic densities throughout decommissioning.

New Nuclear Alternatives

According to 10 CFR Part 52, decommissioning impacts for a nuclear power plant include all activities related to the safe removal of the facility or site from service and the reduction of residual radioactivity to a level that permits release of the property under restricted conditions or unrestricted use and termination of a license. The decommissioning process and the activities occurring during decommissioning would be similar to those associated with current reactors, (see Sections 2.1.3 and 4.12.2.1).

Environmental consequences would also be similar to those discussed in Section 4.12.2.1 and would include:

- Temporary impacts on land use and visual resources, including the construction of temporary buildings and parking lots and the addition or expansion of laydown areas. (Many plants have existing, previously disturbed areas available for these temporary land use activities.)

- Reduced (small) water use and water quality impacts as water consumption decreases significantly after cessation of operations. Dewatering and water used for spent fuel cooling would continue until spent fuel was removed from the site. Surface water runoff or release of substances would be possible but should not have a detectable effect on the environment.

- Temporary increases in local traffic that would result from the additional workforce onsite; truck and rail traffic bringing deconstruction equipment to the site; and the transport of dismantled structures, removed equipment, and waste from the site.

- Long-term reestablishment of vegetation and wildlife communities.

- Short-term improvements in the local economy because of the increased workforce for decommissioning activities, followed by a long-term downturn of the local economy because of the loss of jobs of operational personnel.

- Potential (regulated) radiological doses to the public and decommissioning workforce at the facility from activities such as removal of the reactor vessel and demolition of facilities.

- Increased but temporary occupational safety and health risk to the workforce due to complex and concentrated industrial activities.

Renewable Alternatives

The termination of power plant operations and the decommissioning of renewable energy systems would be similar to the impacts discussed in the previous sections. Decommissioning would follow a decommissioning plan and would involve not only removal of facility components and operational wastes and residues, but also reclamation of the land to its original state. Decommissioning scenarios are expected to involve the following actions:

- Removal of all unneeded structures and facilities to at least 3 ft (1 m) below grade (to provide an unencumbered root zone for site revegetation).
- Removal of all unspent biomass fuel and all solid wastes from combustion and facility maintenance.
- Removal of water intake and discharge structures (if present to support combustion facilities and steam cycles).
- Dismantlement and/or removal of all ancillary facilities, including rail spurs, biomass (and coal) fuel handling and preparation facilities, cooling towers, natural gas pipelines, onsite wastewater treatment facilities, and access roads.
- Removal of all surface water intake and discharge structures.
- Removal of all accumulated sludge, and closure and removal of all surface water impoundments.
- Proper closure of all onsite groundwater wells.
- Aggressive recycling program for removed equipment and dismantled building components; materials awaiting recycling would be stored at an offsite facility.
- Minimal delay times for removed materials and equipment at temporary laydown areas.
- Expeditious disposal of solid and hazardous wastes at approved facilities; remediation as necessary of waste handling and storage areas.
- Cleanup and remediation of all incidental spills and leaks.
- Successful execution of an approved revegetation plan for the site.

- Offsite ancillary facilities (access roads, utilities, pipelines, electrical transmission towers) would be removed unless it is determined that they can serve other purposes; buried utilities and pipelines could be abandoned in place if their removal would result in significant disruption to ecosystems.

- Other actions as necessary to ensure restoration of the site to a condition equivalent in character and value to the greenfield or brownfield site on which the facility was first constructed.

Termination of operations and decommissioning of offshore facilities could involve the following unique actions and strategies, depending on location:

- Wind turbine tower foundations and communication and power cables buried in the seafloor could be allowed to remain to avoid the disruption that would result from their removal.

- Underwater structures could be allowed to remain in place to serve as artificial fish habitats.

- Structures that served as electrical service platforms could be allowed to remain in place to serve as artificial reefs.

The termination of operations and the decommissioning of hydroelectric facilities could follow unique paths. For large store-and-release facilities, eliminating the dam and reservoir and restoring the river to its natural flow could have dramatic consequences to both upstream and downstream ecosystems. Especially where store-and-release dams serve purposes other than power generation (e.g., flood control and irrigation), complete elimination of the structures and reservoir and restoration of original river conditions could be at cross purposes. While turbines, generators, and other equipment associated with power production could be removed, the dam and reservoir would be expected to remain largely intact, as would fish ladders and passages. Penstocks and other devices that control the release of water from the reservoir are expected to remain functional. A reduced workforce would also remain to operate the dam for flood control and irrigation purposes. Impacts on upstream land uses would remain generally unaltered from the impacts during the dam's operating period.

Smaller scale, run-of-the-river dams (so called low-impact hydro facilities[e]) that have limited impact on upstream water levels and downstream water flow rates would likely be completely dismantled and removed during decommissioning.

(e) Low-impact hydro facilities are considered to have a power capacity of less than 30 MW.

4.12.3 Greenhouse Gas Emissions and Climate Change

The following sections discuss greenhouse gas (GHG) emissions from the nuclear lifecycle, replacement power alternatives, and climate change impacts.

4.12.3.1 Greenhouse Gas Emissions

This section discusses GHG emissions from the nuclear lifecycle and compares these emissions to those from fossil and other renewable energy sources. The nuclear lifecycle consists of the uranium fuel cycle phases, as discussed in Section 4.12.1.1, and nuclear power plant construction, operation, and decommissioning.

Existing Studies

The relative volumes of GHGs emitted by nuclear and other electricity generating methods have been widely studied. However, estimates and projections of the carbon footprint of the nuclear lifecycle vary depending on the type of study done. Additionally, considerable debate also exists among researchers on the relative effects of nuclear and other forms of electricity generation on GHG emissions. Existing studies on GHG emissions from nuclear power plants generally take two different forms:

(1) Qualitative discussions of the potential to use nuclear power to reduce GHG emissions and mitigate global warming.

(2) Technical analyses and quantitative estimates of the actual amount of GHGs generated by the uranium fuel cycle or entire nuclear lifecycle and comparisons to the operational or lifecycle emissions from other energy generation alternatives.

Qualitative Studies

The qualitative studies consist primarily of broad, large-scale public policy or investment evaluations of whether an expansion of nuclear power is likely to be a technically, economically, or politically workable means of achieving global GHG reductions. Studies found by the staff during the subsequent literature search include the following:

- Evaluations to determine if investments in nuclear power in developing countries should be accepted as a flexibility mechanism to assist industrialized nations in achieving their GHG reduction goals under the Kyoto Protocols (IAEA 2000; NEA and OECD 2002; Schneider 2000). Ultimately, the parties to the Kyoto Protocol did not approve nuclear power as a component under the Clean Development Mechanism due to safety and waste disposal concerns (NEA and OECD 2002).

- Analyses developed to assist governments, including the United States Government, in making long-term investment and public policy decisions in nuclear power (Hagen et al. 2001; Keepin 1988; MIT 2003).

Although the qualitative studies sometimes reference and critique the existing quantitative estimates of GHGs produced by the nuclear fuel cycle or lifecycle, their conclusions generally rely heavily on discussions of other aspects of nuclear policy decisions and investment such as safety, cost, waste generation, and political acceptability. Therefore, these studies are typically not directly applicable to an evaluation of GHG emissions associated with the proposed license renewal for a given nuclear power plant.

Quantitative Studies

A large number of technical studies, including calculations and estimates of the amount of lifecycle GHGs emitted by nuclear and other power generation options, are available in the literature and were useful to the staff's efforts in addressing relative GHG emission levels. Examples of these studies include—but are not limited to—Mortimer (1990), Andseta et al. (1998), Spadaro et al. (2000), Fritsche (2006), Parliamentary Office of Science and Technology (POST) (2006), AEA Technology (AEA) (2006), Weisser (2006), and Fthenakis and Kim (2007). In addition, Sovacool (2008) provides a review and synthesis of studies in existence through 2008. The Sovacool (2008) synthesis ultimately uses only 19 of the 103 studies initially considered; the remaining 84 were excluded because they were more than 10 years old, not publicly available, available only in a language other than English, or they presented methodological challenges by relying on inaccessible data, provided overall GHG estimates without allocating relative GHG impacts to different parts of the nuclear lifecycle, or they were otherwise not methodologically explicit. The Intergovernmental Panel on Climate Change (IPCC) has issued a special report on Renewable Energy Sources and Climate Change Mitigation (IPCC 2011). This report provides an assessment of previously published literature on lifecycle GHG emissions from various electricity generation technologies (nuclear, fossil fuel, and renewable energy sources). The IPCC report only included in its synthesis published literature that met the screening criteria for quality and relevance. Of the 2,165 references collected, 296 passed the screening criteria; for the nuclear lifecycle, 125 out of 249 references reviewed passed the screening criteria.

Comparing these studies and others like them is difficult because the assumptions and components of the lifecycles the authors evaluate vary widely. Examples of areas in which differing assumptions make comparing the studies difficult include the following:

- Energy sources that may be used to mine uranium deposits in the future

- Reprocessing or disposal of spent nuclear fuel

- Current and potential future processes to enrich uranium and the energy sources that will power them
- Estimated grades and quantities of recoverable uranium resources
- Estimated grades and quantities of recoverable fossil fuel resources
- Estimated GHG emissions other than carbon dioxide including the conversion to carbon dioxide equivalents per unit of electric energy produced
- Performance of future fossil fuel power systems
- Projected capacity factors for alternative means of generation
- Current and potential future reactor technologies.

Studies may vary with respect to whether all or parts of a power plant's lifecycle are analyzed. That is, a full lifecycle analysis will typically address plant construction, operations, resource extraction (for fuel and construction materials), and decommissioning, whereas a partial lifecycle analysis primarily focuses on operational differences. In addition, as Sovacool (2008) noted, studies vary greatly in terms of age, data availability, and in the disclosure of the study methods used.

In the case of license renewal, a GHG analysis for the portion of the plant's lifecycle attributable to license renewal (operation for an additional 20 years) would not involve GHG emissions associated with construction because construction activities have already been completed at the time of relicensing. In addition, the proposed action of license renewal would also not involve additional GHG emissions associated with facility decommissioning because decommissioning must occur whether the facility is relicensed or not. However, in many studies, the specific contribution of GHG emissions from construction, decommissioning, or other portions of a plant's lifecycle cannot be clearly separated from one another. In such cases, an analysis of GHG emissions would overestimate the GHG emissions attributed to a specific portion of a plant's lifecycle. As Sovacool (2008) noted, many of the available analyses provide markedly lower GHG emissions per unit of plant output, if one assumes that a power plant operates for a longer period of time. Nonetheless, available studies supply some meaningful information with respect to the relative magnitude of the emissions among nuclear power plants as compared to other forms of electric generation as discussed in the following sections.

In Tables 4.12-4, 4.12-5, and 4.12-6, the NRC presents the results of the above-mentioned quantitative studies to supply a weight-of-evidence evaluation of the relative GHG emissions that may result from the proposed license renewal as compared to the potential alternative use of coal-fired, natural gas-fired, and renewable generation. Most studies from Mortimer (1990) onward (through Sovacool 2008) indicate that uranium ore grades and uranium enrichment processes are leading determinants in the ultimate GHG emissions attributable to nuclear power generation. These studies show that the relatively lower order of magnitude of lifecycle GHG emissions from nuclear power, when compared to fossil-fueled alternatives (especially natural gas), could potentially disappear if available uranium ore grades drop sufficiently while enrichment processes continued to rely on the same technologies.

Table 4.12-4. Nuclear Greenhouse Gas Emissions Compared to Coal

Source	GHG Emission Results
Mortimer (1990)	Nuclear—230,000 tons CO_2/year Coal—5,912,000 tons CO_2/year Note: Future GHG emissions from nuclear to increase because of declining ore grade.
Andseta et al. (1998)	Nuclear energy produces 1.4 percent of the GHG emissions compared to coal. Note: Future reprocessing and use of nuclear-generated electrical power in the mining and enrichment steps are likely to change the projections of earlier authors, such as Mortimer (1990).
Spadaro et al. (2000)	Nuclear—2.5 to 5.7 g C_{eq}/kWh[(a)] Coal—264 to 357 g C_{eq}/kWh
Fritsche (2006) (values estimated from graph in Figure 4)	Nuclear—33 g C_{eq}/kWh Coal—950 g C_{eq}/kWh
POST (2006) (nuclear calculations from AEA 2006)	Nuclear—5 g C_{eq}/kWh Coal—>1,000 g C_{eq}/kWh Note: Decrease of uranium ore grade to 0.03 percent would raise nuclear to 6.8 g C_{eq}/kWh. Future improved technology and carbon capture and storage could reduce coal-fired GHG emissions by 90 percent.
Weisser (2006) (compilation of results from other studies)	Nuclear—2.8 to 24 g C_{eq}/kWh Coal—950 to 1,250 g C_{eq}/kWh
Sovacool (2008) (compilation of results from other studies)	Nuclear—1.4 to 288 g C_{eq}/kWh (average: 66 g C_{eq}/kWh) Coal —960 to 1,050 g C_{eq}/kWh (coal adopted from Gagnon et al. 2002)
IPCC (2011) (compilation of results from other studies)	Nuclear—1 to 220 g C_{eq}/kWh (median: 16 g C_{eq}/kWh) Coal—675 to 1689 g C_{eq}/kWh (median: 1001 g C_{eq}/kWh)

(a) g C_{eq}/kWh = grams of carbon equivalent per kilowatt-hour

Summary of Nuclear Greenhouse Gas Emissions Compared to Coal

Considering that coal fuels the largest share of electricity generation in the United States and that its burning results in the largest emissions of GHGs for any of the likely alternatives to nuclear power generation, many available quantitative studies focused on comparisons of the relative GHG emissions of nuclear to coal-fired generation. The quantitative estimates of lifecycle GHG emissions associated with nuclear power, as compared to an equivalent coal-fired plant, are presented in Table 4.12-4. The staff relied on current available information for its independent analysis. Although Table 4.12-4 does not include all existing studies, it gives an illustrative range of estimates developed by various sources.

Table 4.12-5. Nuclear Greenhouse Gas Emissions Compared to Natural Gas

Source	GHG Emission Results
Spadaro et al. (2000)	Nuclear—2.5 to 5.7 g C_{eq}/kWh[(a)] Natural Gas—120 to 188 g C_{eq}/kWh
Fritsche (2006) (values estimated from graph in Figure 4)	Nuclear—33 g C_{eq}/kWh Cogeneration Combined Cycle Natural Gas—150 g C_{eq}/kWh
POST (2006) (nuclear calculations from AEA 2006)	Nuclear—5 g C_{eq}/kWh Natural Gas—500 g C_{eq}/kWh Note: Decrease of uranium ore grade to 0.03 percent would raise nuclear to 6.8 g C_{eq}/kWh. Future improved technology and carbon capture and storage could reduce natural gas GHG emissions by 90 percent.
Weisser (2006) (compilation of results from other studies)	Nuclear—2.8 to 24 g C_{eq}/kWh Natural Gas—440 to 780 g C_{eq}/kWh
Sovacool (2008) (compilation of results from other studies)	Nuclear—1.36 to 288 g C_{eq}/kWh (average: 66 g C_{eq}/kWh) Natural Gas—443 g C_{eq}/kWh (natural gas adopted from Gagnon et al 2002)
IPCC (2011) (compilation of results from other studies)	Nuclear—1 to 220 g C_{eq}/kWh (median: 16 g C_{eq}/kWh) Natural gas—290 to 930 C_{eq}/kWh (median: 469 g C_{eq}/kWh)

(a) g C_{eq}/kWh = grams of carbon equivalent per kilowatt-hour

Table 4.12-6. Nuclear Greenhouse Gas Emissions Compared to Renewable Energy Sources

Source	GHG Emission Results
Mortimer (1990)	Nuclear—230,000 tons CO_2/year Hydropower—78,000 tons CO_2/year Wind power—54,000 tons CO_2/year Tidal power—52,500 tons CO_2/year Note: Future GHG emissions from nuclear to increase because of declining ore grade.
Spadaro et al. (2000)	Nuclear—2.5 to 5.7 g C_{eq}/kWh[a] Solar PV[b]—27.3 to 76.4 g C_{eq}/kWh Hydroelectric—1.1 to 64.6 g C_{eq}/kWh Biomass—8.4 to 16.6 g C_{eq}/kWh Wind—2.5 to 13.1 g C_{eq}/kWh
Fritsche (2006) (values estimated from graph in Figure 4 of study)	Nuclear—33 g C_{eq}/kWh Solar PV—125 g C_{eq}/kWh Hydroelectric—50 g C_{eq}/kWh Wind—20 g C_{eq}/kWh
POST (2006) (nuclear calculations from AEA 2006)	Nuclear—5 g C_{eq}/kWh Biomass—25 to 93 g C_{eq}/kWh Solar PV—35 to 58 g C_{eq}/kWh Wave/Tidal—25 to 50 g C_{eq}/kWh Hydroelectric—5 to 30 g C_{eq}/kWh Wind—4.64 to 5.25 g C_{eq}/kWh Note: Decrease of uranium ore grade to 0.03 percent would raise nuclear to 6.8 g C_{eq}/kWh.
Weisser (2006) (compilation of results from other studies)	Nuclear—2.8 to 24 g C_{eq}/kWh Solar PV—43 to 73 g C_{eq}/kWh Hydroelectric—1 to 34 g C_{eq}/kWh Biomass—35 to 99 g C_{eq}/kWh Wind—8 to 30 g C_{eq}/kWh
Fthenakis and Kim (2007)	Nuclear—16 to 55 g C_{eq}/kWh Solar PV—17 to 49 g C_{eq}/kWh
Sovacool (2008) (compilation of results from other studies)	Nuclear—1.36 to 288 g C_{eq}/kWh (average: 66 g C_{eq}/kWh) Wind—9 to10 g C_{eq}/kWh Hydroelectric (small, distributed) —10 to13 g C_{eq}/kWh Biogas digester—11 g C_{eq}/kWh Solar Thermal—13 g C_{eq}/kWh Biomass—14 to 35 g C_{eq}/kWh Solar PV—32 g C_{eq}/kWh Geothermal (hot, dry rock)—38 g C_{eq}/kWh (Note: Solar PV value adopted from Fthenakis et al. 2008; all other renewable-generation values adopted from Pehnt 2006)

Table 4.12-6. (cont.)

Source	GHG Emission Results
IPCC (2011) (compilation of results from other studies)	Nuclear—1 to 220 g C_{eq}/kWh (median: 16 g C_{eq}/kWh) Wind—2 to 81 g C_{eq}/kWh (median: 12 g C_{eq}/kWh) Hydropower—0 to 43 g C_{eq}/kWh (median: 4 g C_{eq}/kWh) Biopower[(c)]—[-]633 to 360 g C_{eq}/kWh (median: 18 g C_{eq}/kWh) Solar PV—5 to 217 g C_{eq}/kWh (median: 46 g C_{eq}/kWh) Solar CSP[(d)]—7 to 89 g C_{eq}/kWh (median: 22 g C_{eq}/kWh) Geothermal—6 to 79 g C_{eq}/kWh (median: 45 g C_{eq}/kWh) Ocean Energy—2 to 23 g C_{eq}/kWh (median: 8 g C_{eq}/kWh)

(a) g C_{eq}/kWh = grams of carbon equivalent per kilowatt-hour
(b) Solar PV = solar photovoltaic
(c) Negative values for biopower refer to avoided emissions. Negative values are based on assumptions of avoided emissions by using wastes and residues from landfill disposals to produce electricity that are credited to the lifecycle of biopower (i.e., biomass is diverted from landfills and emissions that would normally be produced at the landfill are avoided). Avoided emissions are those that may be misplaced in time and location but which do totally remove GHGs from the atmosphere.
(d) CSP = concentrating solar power.

Summary of Nuclear Greenhouse Gas Emissions Compared to Natural Gas

The quantitative estimates of lifecycle GHG emissions associated with the nuclear power, as compared to an equivalent natural gas-fired plant, are presented in Table 4.12-5. The staff relied on current available information for its independent analysis. The staff notes that Table 4.12-5 does not include all existing studies. Table 4.12-5, however, gives an illustrative range of estimates developed by various sources.

Summary of Nuclear Greenhouse Gas Emissions Compared to Renewable Energy Sources

The quantitative estimates of lifecycle GHG emissions associated with the nuclear power, as compared to equivalent renewable energy sources, are presented in Table 4.12-6. Calculation of GHG emissions associated with these sources is more difficult than the calculations for nuclear energy and fossil fuels because of the large variation in efficiencies and capacity factors due to their different technologies, sources, and locations. For example, the efficiencies of solar and wind energy are highly dependent on the wind or solar resource in a particular location. Similarly, the range of GHG emissions estimates for hydropower varies greatly depending on the type of dam or reservoir involved (if used at all). Additionally, for biopower, the biomass source (energy crops, agricultural and livestock waste, etc.) and broad range of bioenergy technologies (direct combustion, biomass integrated gasification combined cycle, co-firing with coal) impact lifecycle GHG emissions estimates. For instance, emissions can be avoided if agricultural waste, that would typically decompose and emit GHGs, is used as the biomass source to produce electricity. However, biomass power plant operation, construction, and transportation still emit GHGs. On the other hand, if energy crops are used, GHGs are emitted from the manufacturing or harvesting of biomass, transportation, construction, and operation of the plant. Therefore, lifecycle GHG emissions estimates for these energy sources have a greater range of variability than the estimates for nuclear and fossil fuel sources. Table 4.12-6 gives an illustrative range of estimates developed by various sources.

Conclusions: Relative Greenhouse Gas Emissions

The sampling of data presented in Tables 4.12-4, 4.12-5, and 4.12-6 demonstrates the wide distribution of lifecycle GHG emission estimates of various electricity generation technologies and the challenges of any attempt to determine the specific amount of GHG emissions attributable to nuclear energy production sources, as different assumptions and calculation methods will yield differing results. The differences and complexities in these assumptions and analyses will further increase when they are used to project future GHG emissions. Nevertheless, several conclusions can be drawn from the information presented.

First, the various studies show a general consensus that nuclear power generation has lower lifecycle GHG emissions than electrical generation based on fossil fuel. The studies also give estimates of lifecycle GHG emissions from renewable energy sources based on current and available technology. The range of these estimates is wide, but the general conclusion is that current lifecycle GHG emissions from nuclear power generation are of the same order of magnitude as from the surveyed renewable energy sources.

Second, the studies show no consensus on future relative GHG emissions from nuclear power and other sources of electricity. There is substantial disagreement among the various authors about the GHG emissions associated with declining uranium ore concentrations, future uranium enrichment methods, and other factors, including changes in technology. Similar disagreement exists about future GHG emissions associated with coal and natural gas for electricity generation. Even the most conservative studies conclude that nuclear power generation currently produces fewer lifecycle GHG emissions than sources based on fossil fuel and is expected to continue to do so in the near future. The primary difference among the authors is the projected cross-over date (the time at which GHG emissions from the nuclear lifecycle exceed those of sources based on fossil fuel) or whether cross-over will actually occur.

Considering the current estimates and future uncertainties, it appears that GHG emissions associated with nuclear power plant relicensing actions are likely to be lower than those associated with energy sources based on fossil fuel. This conclusion is based on the following rationale:

- As shown in Tables 4.12-4 and 4.12-5, the current estimates of lifecycle GHG emissions from nuclear power generation are below those for energy sources based on fossil fuel.

- License renewal will involve continued GHG emissions due to uranium mining, processing, and enrichment but will not result in increased GHG emissions associated with plant construction or decommissioning (as the plant will have to be decommissioned at some point whether the license is renewed or not).

- Few studies predict that nuclear lifecycle emissions will exceed those of fossil fuels within a time frame that includes periods of extended operation. Several studies suggest that future extraction and enrichment methods, the potential for higher grade uranium resource discovery, and technology improvements could extend this time frame.

With respect to the comparison of GHG emissions among nuclear power plant license renewal and renewable energy sources, it appears likely that there will be future technology improvements and changes in the type of energy used for mining, processing, manufacturing, and constructing facilities of all types. Currently, lifecyle GHG emissions associated with nuclear power and renewable energy sources are within the same order of magnitude. Because nuclear fuel production is the most significant contributor to possible future increases in GHG emissions from nuclear power—and because most renewable energy sources lack a fuel component—it is likely that GHG emissions from renewable energy sources would be lower than those associated with nuclear power plant license renewal at some point during the period of extended operation.

4.12.3.2 Climate Change Impacts

This section briefly describes the environmental impacts that could occur from changes in global and regional climate conditions due to GHG emissions. Each subsection generically describes potential long-term impacts and provides examples of the resource changes that could occur due to climate change.

Land Use

Sea level rise could result in the loss of coastal lands, as well as the possible loss of man-made infrastructure as a result of inundation, flooding during storm events, or storm-triggered erosion. This could necessitate more-frequent infrastructure redesign and replacement or relocation away from potential hazards. As noted by the U.S. Global Change Research Program (USGCRP) (2009), the projected rapid rate and large amount of climate change over the next century will challenge the ability of society and natural systems to adapt. For example, it is difficult and expensive to alter or replace infrastructure designed to last for decades (such as buildings, bridges, roads, airports, reservoirs, and ports) in response to continuous and/or abrupt climate change. Sea-level rise and storm surge place many U.S. coastal areas at increasing risk of erosion and flooding, especially along the Atlantic and Gulf coasts, the Pacific

Islands, and parts of Alaska. Energy and transportation infrastructure and other property in coastal areas are also likely to be adversely affected.

Air Quality and Meteorology

The EPA annually publishes the official United States inventory of GHG emissions that identifies and quantifies the primary man-made sources and sinks of GHGs. The EPA estimates that energy-related activities in the United States account for more than three-quarters of human-generated GHG emissions, mostly in the form of carbon dioxide emissions from burning fossil fuels. More than half of the energy-related emissions come from major stationary sources like power plants, and approximately one-third comes from transportation. Industrial processes (production of cement, steel, and aluminum), agriculture, forestry, other land use, and waste management are also important sources of GHG emissions in the United States (EPA 2011).

Section 4.12.3.1 presents a discussion of the relative GHG emissions from nuclear power and other electricity generation options. The impacts of GHG emissions do not vary with the locations of the emissions sources, so the same impacts would result from the operation of those power plants regardless of where they are located. The USGCRP indicates that as much as 87 percent of GHG emissions are the result of generating electricity and heat using carbon-based fuels (USGCRP 2009).

With regard to the impact of GHG emissions, the USGCRP concludes in part that climate-related changes have already been observed globally and across the United States. Specifically, it notes the following changes: increases in air and water temperatures, reduced frost days, increased frequency and intensity of heavy downpours, a rise in sea level, and reductions in snow cover, glaciers, permafrost, and sea ice. Longer ice-free periods on lakes and rivers, lengthening of the growing season, and increased water vapor in the atmosphere have also been observed. These climate-related changes are expected to continue while new ones develop. Likely future changes for the United States and surrounding coastal waters include more-intense hurricanes with related increases in wind, rain, and storm surges (but not necessarily an increase in the number of these storms that make landfall), as well as drier conditions in such areas as the Southwest (USGCRP 2009). Climate model simulations presented by the U.S. National Oceanic Atmospheric Administration indicate a greater rate of warming (average temperature increase) over the entire continental United States for the 21st century than the 20th century observed rates, an increase in the number of days with a maximum temperature greater than 95˚F (35°C) in the Southwest and Southeast regions, a decrease in the number of days with minimum temperatures less than 10˚F (–12°C) in the Rocky Mountains and Northern regions, and an increase in the number of days with little or no precipitation (less than 0.04 in. [0.1 mm]) for Western and Southern regions by mid-century for a high-emissions scenario (continued increases in greenhouse gas emissions through the end of the century) (NOAA 2013). Observed changes in meteorological and climatological indicators specific to the continental United States are further discussed in Section 3.3.1 of this GEIS.

Water Resources

Climate change will affect water availability in every region of the United States, but the nature of the potential impacts varies. Drought-—related to reduced precipitation, increased evaporation, and increased water loss from plants in response to higher temperatures—is an important issue in many regions, especially in the West. Floods, as well as water quality problems, are likely to be amplified by climate change in most regions. Declines in mountain snowpack are important in the West and Alaska where snowpack provides vital natural water storage. In some regions, reductions in water supply due to decreases in precipitation and/or reduced snowmelt will increase competition for water among various sectors, including energy production (USGCRP 2009).

More specifically, the USGCRP projects a high likelihood that water shortages will limit power plant electricity production in some regions. USGCRP projects water constraints on electricity production by 2025 in Arizona, Utah, Texas, Louisiana, Georgia, Alabama, Florida, California, Oregon, and Washington State. Additional parts of the United States could face similar constraints as a result of drought, growing populations, and increasing demand for water for various uses during some or all seasons.

Finally, the issue related to water resources is not only one of water availability, but also of water temperature. Warmer water and higher air temperatures reduce the efficiency of thermal power plant cooling technologies. In addition, discharge-permit conditions may limit operations for some power plants as water temperatures rise (this has already occurred at some power plants during peak summer heat). In the aggregate, these changes may reduce the available power generating capacity during the summer, when demand is typically high. A relatively small change in available generating capacity could have significant implications for the total national electric power supply. An average reduction of 1 percent in electricity generated by thermal power plants nationwide would mean a loss of 25 billion kilowatt-hours per year—equivalent to the amount of electricity consumed by 2 million Americans. Such a power loss would need to be replaced or otherwise offset through improvements in energy efficiency (USGCRP 2009).

Terrestrial Resources

Climate change could affect terrestrial resources. Sea level rise could result in the loss of coastal marsh and cause saltwater intrusion into coastal forests (USGCRP 2009), thus eliminating habitat for wildlife. Global climate change could also cause shifts in species' ranges and migratory corridors, as well as changes in ecological processes (NRC 2011).

Climate change is already having effects on terrestrial animal and plant species throughout the United States. Some of the most obvious changes are related to the timing of the seasons, including when plants bud in spring and when birds and other animals migrate. Spring now arrives an average of 10 days to two weeks earlier than it did 20 years ago, and the growing season is lengthening over much of the continental United States. The ranges of many species in the United States have shifted northward in latitude and upward in elevation. As an example, the ranges of many butterfly species have expanded northward, contracted at their southern edges, and shifted to higher elevations as warming has continued. Also, horticultural hardiness zones (each zone represents a 10°F (5.6°C) change in minimum temperature) in the Midwest are likely to shift one-half to one full zone about every 30 years. Impacts on forests are likely to be mixed, with limited, positive effects of higher carbon dioxide levels potentially negated by the negative effects of decreased water supply (in the West) and more-frequent severe weather events like storms and droughts throughout the United States. On a broader scale, some common forests types are projected to expand, such as oak-hickory; others are projected to contract, such as maple-beech-birch. Still others, such as spruce-fir, are likely to disappear from the United States altogether (USGCRP 2009).

The potential for animals to shift their ranges to keep pace with the changing climate may be inhibited by major urban areas and by natural barriers like the Great Lakes. Insect pests that have historically been controlled by cold winters will more easily survive milder winters and may produce larger populations in areas that are already within their ranges. Further, increased temperatures, decreased rainfall, and more-severe droughts could also lead to the drying of lakes, ponds, and wetlands and the loss of riparian species (USGCRP 2009).

The Intergovernmental Panel on Climate Change has estimated that if a warming of 3.5 to 5.5°F (1.9 to 3°C) occurs, 20 to 30 percent of species that have been studied would be located in climate zones that are outside of their current ranges and would, therefore, likely be at risk of extinction. This high percentage is partly a result of pre-existing stresses, including habitat loss and continued overharvesting of some species (USGCRP 2009).

Aquatic Resources

The potential effects of climate change, whether from natural cycles or related man-made activities, could result in a variety of changes that would affect inland and coastal aquatic resources.

Water temperatures in lakes, streams, and rivers have been increasing across most of the United States and will continue to do so as air temperatures increase. According to USGCRP (2009), in some lakes for example, "this will lead to an earlier and longer period in summer during which mixing of the relatively warm surface lake water with the colder water below is reduced. In such cases, this stratification can cut off oxygen from bottom layers, increasing the risk of oxygen-poor or oxygen-free ‘dead zones’ that kill fish and other living things.” In lakes with contaminated sediment, warmer water and low-oxygen conditions can more readily mobilize mercury and other persistent pollutants. In cases where increasing quantities of contaminants are taken up in the aquatic food chain, there will be additional potential for health hazards for species, including humans, that eat fish from the lakes. “Populations of coldwater fish, such as brook trout, lake trout, and whitefish, are expected to decline dramatically, while populations of coolwater fish such as muskellunge, and warmwater species such as smallmouth bass and bluegill, will take their places” (USGCRP 2009). Overall, large declines in trout populations are projected to occur around the United States “Over half of the wild trout populations are likely to disappear from the southern Appalachian Mountains because of the effects of rising stream temperatures. Losses of western trout populations may exceed 60 percent in certain regions” (USGCRP 2009). Aquatic ecosystem disruptions are likely to be compounded by invasions of non-native species that tend to thrive under a wide range of environmental conditions.

The environmental factors of significance that could affect estuarine systems include sea level rise, temperature increases, salinity changes, and wind and water circulation changes (Kennedy 1990). Changes in sea level could result in effects to nearshore communities, including the reduction or redistribution of submerged and emergent aquatic vegetation, changes in marsh communities, and influences to other wetland areas adjacent to nearshore systems. Sea level rise may outpace the ability of estuarine systems to migrate, and thus some habitats may be lost altogether. Water temperature changes could affect spawning patterns and success, and may influence the distribution of important species (e.g., cold water species may move northward while the ranges of warm water species expand). Changes in salinity could also influence the spawning and distribution of important species and the range of invasive species. Fundamental changes in precipitation could influence water circulation, salinity and mixing patterns, and change the nature of sediment and nutrient inputs to the system. This could result in changes to primary production and influence the estuarine food web. Some fisheries and aquaculture enterprises might benefit from climate change while others might suffer (Kennedy 1990). However, climate change could increase the frequency of red tide blooms, with adverse impacts to many fish species (USFWS and NMFS 2009).

In marine ecosystems, climate change may trigger effects similar to those in estuarine ecosystems. Effects may additionally include adverse impacts to corals, clams, shrimp, and other organisms with calcium carbonate shells or skeletons due to increased acidity (a side-effect that occurs when increased atmospheric carbon dioxide concentrations diffuse into the oceans); coral bleaching and increases in the rate of disease in corals; and more-frequent die-offs of sponges, seagrasses, and other organisms could occur as sea temperatures increase (Florida Oceans and Coastal Council 2009).

Historic and Cultural Resources

Sea level rise and changes in meteorological conditions due to climate change could result in the loss of historic and cultural resources due to short-term flooding, erosion, or long-term inundation. Due to the differences in timing and rate of climate and sea-level changes, it is possible that some resources could be lost before they could be documented or otherwise studied.

Socioeconomics

Changes in climate conditions could have an impact on the availability of jobs in certain industries. For example, the USGCRP noted that tourism and recreation are major job creators in some regions, bringing billions of dollars to regional economies. Across the nation, fishing, hunting, skiing, snowmobiling, diving, beach-going, and other outdoor activities make important economic contributions and are also a part of tradition. A changing climate would mean reduced opportunities for some activities in some locations and expanded opportunities for others. Hunting and fishing opportunities will change as animals' habitats shift and as relationships among species are disrupted by their different responses to climate change. Water-dependent recreation in areas projected to get drier, such as the Southwest, and beach recreation in coastal areas (which are expected to see rising sea levels) will suffer. Some regions will see an expansion of the season for warm weather recreation such as hiking and bicycle riding, while other areas will see a decline in—or elimination of—cold-weather recreation (USGCRP 2009).

Human Health

Increasing temperatures due to changes in climate conditions could have an impact on human health. The ranges of disease-carrying insects and animals may expand. At the same time, hotter weather may increase the incidence of health-threatening air pollution events (USGCRP 2009). This is in addition to the risk to life and property resulting from sea-level rise, intense precipitation events, flooding, erosion, and storm surge. Unusually intense storm events can also overload drainage systems and water treatment facilities, increasing the risk of waterborne diseases (USGCRP 2009).

Environmental Justice

Changes in climate conditions could disproportionately affect minority and low-income populations. The USGCRP (2009) indicates that "infants and children, pregnant women, the elderly, people with chronic medical conditions, outdoor workers, and people living in poverty are especially at risk from a variety of climate-related health effects." Examples of these effects include increased heat stress, air pollution, extreme weather events, and diseases carried by food, water, and insects. The greatest health burdens related to climate change are likely to fall on the poor, especially those lacking adequate shelter and access to other resources such as air conditioning. Elderly people, who are more likely to be poor, are also more likely to have debilitating chronic diseases or limited mobility. In addition, the elderly have a reduced ability to regulate their own body temperature or sense when they are too hot. According to the USGCRP (2009), they "are at greater risk of heart failure, which is further exacerbated when cardiac demand increases in order to cool the body during a heat wave." The USGCRP study also found that people taking medications, such as diuretics for high blood pressure, have a higher risk of dehydration.

Cumulative Impacts

The USGCRP found that climate change will combine with other social, economic, and environmental stresses to create larger impacts than from any of these factors alone (USGCRP 2009). In addition, the cumulative impacts of climate change will be further examined in each site-specific SEIS.

4.13 Cumulative Impacts of the Proposed Action

Cumulative impact is defined by the CEQ in 40 CFR 1508.7. Actions to be considered in cumulative impact analyses include new and continuing activities, such as license renewal, that are conducted, regulated, or approved by a Federal agency. The cumulative impacts analysis takes into account all actions, however minor, since impacts from individually minor actions may be significant when considered collectively over time. The goal of the cumulative impact analysis is to identify potentially significant impacts to improve decisions and move toward more sustainable development (CEQ 1997; EPA 1999).

The analysis of cumulative impacts focuses on resources that could be affected by the incremental impacts from continued operations and refurbishment of the nuclear power plant associated with license renewal. The CEQ discusses the assessment of cumulative effects in detail in its report entitled, *Considering Cumulative Effects Under the National Environmental Policy Act* (CEQ 1997). On the basis of the guidance provided in the CEQ report, a cumulative impact analysis would consider the following:

> ***Definition of Cumulative Impact***
>
> The impact on the environment that results from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions.

- The geographic scope (i.e., regions of influence). The regions of influence encompass the areas of affect and the distances at which impacts associated with license renewal may occur. Geographic boundaries may vary by resource area and the distances over which an impact may be experienced (e.g., the evaluation of impacts on air quality may have a greater regional extent than that of impacts on historic and cultural resources).

- The time frame for the analysis. The time frame incorporates the sum of the effects of license renewal in combination with past, present, and reasonably foreseeable future actions since impacts may accumulate or develop over time. The time frame for future actions is the 20-year license renewal term after the end of the original license term. Past and present actions include all actions up to and including the time of the license renewal application. Future actions are those that are "reasonably foreseeable"; that is, they are ongoing (and will continue into the future), are funded for future implementation, or are included in firm, near-term plans. Past and present actions are generally accounted for in the baseline assessment presented in the affected environment sections for each resource area in Chapter 3 of this GEIS. The direct and indirect impact analyses present in Chapter 4 address the incremental impacts of license renewal. These analyses are carried forward to the cumulative impact analysis, which expands the analysis to consider other past, present, and reasonably foreseeable future actions.

- The potential effects of each past, present, or reasonably foreseeable future action. Both the license renewal and other actions (related and nonrelated, including trends such as global climate change) will generate effects that could contribute to cumulative impacts. The impacts of activities associated with the proposed action (license renewal) are discussed for each resource area in this chapter. In cases where the contributions of activities to an impacting factor are uncertain or not well known, a qualitative evaluation is made.

For some resource areas (e.g., water and aquatic resources), the contributions of ongoing actions within a region to cumulative impacts are regulated and monitored through a permitting process (e.g., NPDES) under State or Federal authority. In these cases, it may be assumed that cumulative impacts are managed as long as these actions (facilities) are in compliance with their respective permits.

The following sections describe the environmental resource areas that could be affected by past, present, and reasonably foreseeable future actions that, combined with the effects of the proposed license renewal action, could result in cumulative impacts. For the most part, environmental conditions in the vicinity of nuclear power plants are not expected to change during the license renewal term much beyond what is currently being experienced. Cumulative impacts are considered a Category 2 issue requiring a plant-specific analysis as part of the license renewal environmental review.

4.13.1 Air Quality

Regional air quality conditions could deteriorate from the cumulative effects of emissions associated with past, present, and reasonably foreseeable urban, industrial, commercial, agricultural, and transportation development. These activities give rise to dust, exhaust, and evaporative emissions that degrade air quality. The magnitude of cumulative impacts would depend on the location of the nuclear power plant and the number, type, and intensity of development within the airshed and its location relative to air quality nonattainment areas.

4.13.2 Noise

Noise levels in the vicinity of a nuclear power plant could increase from planned activities associated with urban, industrial, and commercial development. The magnitude of cumulative impacts would depend on a nuclear plant's proximity to other noise sources.

4.13.3 Geology and Soils

Cumulative impacts on geologic resources relate to issues concerning access to mineral or energy resources, destruction of unique geologic features, and mass movement induced by construction activities. These impacts typically result from land disturbance activities (e.g., earthmoving, blasting, grading, and excavation) associated with urban development, industrial and commercial development, water projects, and transportation development. Existing land uses may also affect the access to mineral or energy resources. Impacts on soil resources relate to increases in the potential for soil erosion, which also occurs as a result of land disturbance activities. Vegetation clearing and grading can increase the potential for soil erosion in the absence of soil erosion protection measures. The magnitude of cumulative impacts would depend on the nature and location of the actions and whether appropriate mitigation measures are implemented to reduce the impacts.

4.13.4 Surface Water Resources

Cumulative impacts on surface water resources relate to issues concerning water use and quality. Impacts typically result from activities (e.g., water withdrawal, effluent discharges, accidental spills and releases) associated with urban development, industrial and commercial development, agricultural development, water projects (e.g., dredging), and grazing. Short-duration construction projects (e.g., road construction) can also result in surface water impacts if they increase soil erosion, which, in turn, increases sediment loading to nearby surface water bodies. The magnitude of cumulative impacts would depend on the nature and location of the actions relative to surface water bodies, the number of actions (facilities or projects), and whether facilities comply with regulating agency requirements (e.g., permitted discharge limits).

Perhaps the most important source of surface water impacts is the withdrawal of water for plant cooling systems (both once-through and closed-cycle). These impacts relate to water use conflicts with other users. Although once-through systems return most of their withdrawn water (minus evaporative losses of less than 3 percent), surface water withdrawals for closed-cycle cooling systems can have significant impacts. This is because consumptive losses are much higher (up to 60 percent), resulting in the return of less water (see Section 4.5). These impacts may be greater during times of drought, especially when temperatures are high.

4.13.5 Groundwater Resources

Cumulative impacts on groundwater resources relate to issues concerning water use and quality. Impacts typically result from the water demands associated with urban, industrial and commercial, and agricultural development. Short-duration construction projects could also result in groundwater impacts over time (e.g., from spills), unless BMPs (e.g., spill prevention and control plans and spill containment measures) are employed. The magnitude of cumulative impacts would depend on the number of actions (facilities or projects) that withdraw water from the aquifer, the overall demand on the aquifer, the hydrogeologic characteristics of the aquifer, and whether facilities follow BMPs to protect groundwater resources from degradation and overpumping.

4.13.6 Ecological Resources

Cumulative impacts on terrestrial habitats and wildlife include habitat loss and degradation, disturbance and displacement, injury and mortality, and obstruction of movement. Impacting factors include exposure to elevated noise levels and contaminants, altered surface water and groundwater quality and flow patterns, and hazards associated with direct contact with physical structures (e.g., bird collisions with buildings and other structures). Adverse impacts typically result from activities (e.g., construction) associated with urban sprawl, industrial and commercial development, agricultural development, transportation development, water projects, and regional tourism and recreation. Migratory species may be affected by activities carried out in locations remote from the nuclear plant sites. Plant communities (including floodplain and wetland communities) also may be affected by activities (e.g., clearing and grading) associated with these actions, creating conditions that favor the encroachment of invasive species. The magnitude of cumulative impacts resulting from all actions taking place within the region in which a power plant is located would depend on the nature and location of the actions relative to important wildlife habitats and plant communities, the number (and density) of actions, and the extent to which these actions (facilities or projects) employ mitigation measures to minimize such impacts.

Three scales of cumulative impacts on aquatic resources can be identified: (1) cumulative impacts due to the various impacts from an individual power plant (e.g., entrainment, impingement, thermal discharges, and chemical discharges), (2) cumulative impacts due to closely sited power plants, and (3) cumulative impacts due to multiple activities that affect the water body (e.g., dams, agriculture, urban, and industrial development) (York et al. 2005). Cumulative impacts on aquatic habitats and species include the (1) loss and degradation of habitat; (2) species disturbance, displacement, injury, and mortality; (3) obstruction of movement; and (4) the introduction and spread of invasive species. These impacts result from activities (e.g., increased water use and discharges to natural water bodies, increased and contaminated runoff) associated with urban sprawl; industrial, commercial, agricultural, and transportation development; water projects; and regional tourism and recreation. The magnitude of cumulative impacts would depend on the nature and location of the actions relative to important water bodies, the number (and density) of actions, and the extent to which these actions (facilities or projects) employ mitigation measures to minimize such impacts.

4.13.7 Historic and Cultural Resources

Cumulative impacts on historic and cultural resources relate to the damage or destruction of historic and cultural resources (i.e., archaeological sites, historic structures, and traditional cultural properties, or their context). These impacts typically result from land disturbance (e.g., earthmoving, blasting, grading, and excavation) or maintenance activities associated with urban, industrial and commercial, agricultural, and transportation development (e.g., vegetation clearing). Such activities may directly damage or destroy cultural artifacts or increase the potential for their exposure by accelerating erosion, leaving them vulnerable to theft and vandalism. The magnitude of cumulative impacts would depend on the nature and location of the actions and whether appropriate mitigation measures (in consultation with the SHPO) are implemented.

4.13.8 Socioeconomics

Employment and income are generated by the construction and operation of new industries, including the construction of new nuclear power plants, which can have a significant cumulative socioeconomic effect. Income generated by wages, salaries, and the increased demand for services creates additional demand for goods, public services, and housing. Employment in new industries increases the size of the population and the demand for public services, housing, and transportation. The magnitude of cumulative impacts would depend on the location of the existing nuclear power plant subject to license renewal and the number, type, and intensity of industrial development within the region of impact.

4.13.9 Human Health

Cumulative human health impacts relate to public exposure to radiological, chemical, and microbiological hazards and the potentially chronic effects of EMF exposure. Public exposures may occur as a result of environmental accumulations of harmful constituents released from various facilities associated with urban development, agriculture, and industrial and commercial development. The cumulative impacts of EMF exposure, while uncertain, would relate to activities (e.g., transmission lines and substations) associated with urban, industrial, and commercial development.

The magnitude of cumulative impacts would depend on the nature and location of the actions, the number of actions (facilities or projects), the level of the public's exposure, and whether facilities comply with regulating agency requirements (e.g., permitted discharge limits).

4.13.10 Environmental Justice

Cumulative impacts can result when impacts on various individual resources (air, land, water, and ecology) combine to produce human health and environmental impacts that could be cumulatively high and adverse. Whether these impacts are disproportionately high and adverse to minority and low-income populations depends on the unique characteristics of these populations residing in the vicinity of the nuclear power plant. Potentially adverse human health and environmental impacts from activities associated with industrial, commercial, agricultural, and transportation development can affect the resources on which these populations depend (e.g., fish, game animals, and native vegetation).

4.13.11 Waste Management and Pollution Prevention

Radioactive Waste—There are facilities other than the commercial nuclear power reactors and other uranium fuel cycle facilities that generate radioactive waste. Depending on the locations of these facilities and the locations of treatment and disposal facilities, there could be cumulative impacts resulting from the cumulative effects of transportation, treatment, and disposal activities. However, some nuclear power plants are likely to be the only significant generators of radioactive waste within the region. As a result, the cumulative impacts from radioactive waste management and pollution prevention would be similar to the impact from the overall incremental contribution of license renewal, as discussed in Sections 4.11.1 and 4.12.1.1.

Other Wastes—Waste-generating facilities must comply with Federal and State regulations in terms of storage, treatment, and disposal. In addition, facilities must employ procedures that ensure the proper handling and storage of wastes and monitoring for releases.

4.13.12 Global Climate Change

Global climate change is a global problem resulting from emissions of GHGs both within and beyond the region in which a power plant is located. Changes in climate over the license renewal term have the potential to contribute significantly to cumulative impacts on air and water resources, ecological resources, and human health as a consequence of changes in precipitation, temperature, frequency and severity of storms, sea level, floods, and droughts. Climate change observations and future climate scenarios are documented in reports developed by the U.S. National Oceanic Atmospheric Administration (NOAA 2013) and Intergovernmental Panel on Climate Change (IPCC 2007). The direction and nature of these changes are predicted to vary widely across the country and the regions in which operating nuclear power plants exist. Such effects are documented in the U.S. Global Change Research Program state of knowledge report, *Global Climate Change Impacts in the United States* (USGCRP 2009).

4.14 Resource Commitments Associated with the Proposed Action

This section addresses the resources that would be committed under the proposed action. In particular, it describes unavoidable adverse environmental impacts (Section 4.14.1), the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity (Section 4.14.2), and the irreversible and irretrievable commitment of resources (Section 4.14.3) that would be associated with the proposed action (license renewal). Potential unavoidable adverse environmental impacts and irreversible and irretrievable resource commitments that would be associated with alternatives to the proposed action are also discussed.

4.14.1 Unavoidable Adverse Environmental Impacts

Unavoidable adverse environmental impacts are impacts that would occur after implementation of all feasible mitigation measures. Continued nuclear power plant operations and the implementation of any of the replacement power alternatives considered in this GEIS would result in some unavoidable adverse environmental impacts.

The impacts of continued nuclear power plant operations that are anticipated to occur are discussed for each resource area in Sections 4.1 through 4.11. Some of these impacts cannot be avoided because they are inherently associated with nuclear power plant operations and cannot be fully mitigated. Minor unavoidable adverse impacts on air quality would occur due to emission and release of various chemical and radiological constituents into the environment from plant operations. Nonradiological emissions are expected to comply with EPA emissions standards, though the alternative of operating a fossil-fueled power plant in some areas may worsen existing air quality attainment issues. Routine chemical and radiological emissions would not exceed the National Emission Standards for Hazardous Air Pollutants. Other unavoidable adverse impacts (depending on the plant) include the impact on land use and visual resources, some minor noise effects, surface water and groundwater use, thermal effluents emitted to the environment from the power conversion equipment, and entrainment and impingement of aquatic organisms in the cooling water system.

During nuclear power plant operations, workers and members of the public would face unavoidable exposure to radiation and hazardous and toxic chemicals, but releases would be controlled and the resulting exposures would not exceed any standards or regulatory limits. Workers would be exposed to radiation and chemicals associated with routine plant operations and the handling of nuclear fuel and waste material. Workers would have a higher risk of exposure than members of the public, but doses would be administratively controlled and would not exceed any standards or administrative control limits. Construction and operation of alternative replacement power energy generating facilities would also result in unavoidable exposure to hazardous and toxic chemicals to workers and the general public.

Also unavoidable would be the generation of spent nuclear fuel and waste material, including LLW, hazardous waste, and nonhazardous waste. Hazardous and nonhazardous wastes would also be generated at non-nuclear power generating facilities. Wastes generated during plant operations would be collected, stored, and shipped for suitable treatment, recycling, or disposal in accordance with applicable Federal and State regulations. Due to the costs of handling these materials, power plant operators would be expected to conduct all activities and optimize all operations in a way that generates the smallest amount of waste practical. Although pollution prevention and waste minimization efforts are intended to prevent emissions to the environment and prevent and/or minimize the quantities of waste generated, some waste and emissions cannot be entirely eliminated due to current technology.

Many of these unavoidable impacts are being mitigated by incorporating safety features and/or applying operational procedures at the plants and are monitored by the plant owners and State agencies. Thermal, entrainment, and impingement impacts at plants with once-through cooling water systems are unavoidable. However, these impacts could be reduced by modifying the once-through cooling system or by converting to a closed-cycle cooling system. Although closed-cycle cooling water systems can reduce thermal, entrainment, and impingement impacts, they increase water consumption (through cooling tower evaporation), fogging, icing, and salt drift.

Nuclear power plants being considered for license renewal already exist and have been operating for decades. The environmental impacts considered for license renewal are those associated with continued nuclear power plant operation and refurbishment. Replacement power and other alternatives to license renewal generally involve major construction impacts.

Therefore, unavoidable adverse impacts of a replacement power alternative could be greater than those associated with the continued operation of an existing nuclear power plant.

Unavoidable adverse impacts would vary among the nuclear power plants, and the scale of the impact would depend on the specific characteristics of each power plant and its interaction with the environment. These unavoidable adverse impacts are evaluated in plant-specific SEISs.

4.14.2 Relationship between Short-Term Use of the Environment and Long-Term Productivity

The operation of power generating facilities would result in short-term uses of the environment as described earlier in this Chapter. "Short term" is the period of time during which continued power generating activities would take place.

Power plant operations would necessitate short-term use of the environment and commitments of resources and would also commit certain resources (e.g., land and energy) indefinitely or permanently. Certain short-term resource commitments would be substantially greater under most energy alternatives, including license renewal, than under the no-action alternative due to the continued generation of electrical power as well as continued use of generating sites and associated infrastructure. During operations, all energy alternatives would entail similar relationships between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.

Short-term use of the environment can affect long-term productivity of the ecosystem if that use alters the ability of the ecosystem to reestablish an equilibrium that is comparable to that of its original condition. An initial commitment regarding the trade-off between short-term use and long-term productivity at a nuclear power plant was made when the power plant was first constructed decades ago. Renewal of the operating license and the continued operation of the nuclear power plant would not alter any existing effects on long-term productivity, but they might postpone the availability of the power plant site for other uses. The no-action alternative would lead to a cessation of operations and shutdown of the power plant (an eventuality regardless of whether or not a license is renewed).

Air emissions from power plant operations would introduce small amounts of radiological and nonradiological constituents to the region around the plant site. Over time, these emissions could result in increased concentrations and exposure but are not expected to impact air quality or radiation exposure to the extent that public health and long-term productivity of the environment would be impaired.

Continued employment, expenditures, and tax revenues generated during power plant operations would directly benefit local, regional, and State economies over the short term.

Local governments investing project-generated tax revenues into infrastructure and other required services could enhance economic productivity over the long term.

The management and disposal of spent nuclear fuel, LLW, hazardous waste, and nonhazardous waste would require an increase in energy and would consume space at treatment, storage, or disposal facilities. Regardless of the location, the use of land to meet waste disposal needs would reduce the long-term productivity of the land.

Power plant facilities would be committed to electricity production over the short term. After decommissioning these facilities and restoring the power plant site, the land would become available for other productive uses.

The nature of the relationship between short-term use of the environment and long-term productivity would vary among plants and would depend on the specific characteristics of each plant and its interaction with the environment. This relationship is evaluated in plant-specific SEISs.

4.14.3 Irreversible and Irretrievable Commitment of Resources

Irreversible and irretrievable commitment of resources for electrical power generation would include the commitment of land, water, energy, raw materials, and other natural and manmade resources required for power plant operations during the license renewal term and any refurbishment activities that might be carried out that would not otherwise have taken place if the operating licenses had not been renewed. This section describes the irreversible and irretrievable commitments of resources that have been identified in this GEIS. A commitment of resources is irreversible when primary or secondary impacts limit the future options for a resource. An irretrievable commitment refers to the use or consumption of resources neither renewable nor recoverable for future use. In general, the commitment of capital, energy, labor, and material resources would also be irreversible.

Resources include materials and equipment required for nuclear power plant maintenance and operation, energy and water needed to run the plants, the nuclear fuel used by the reactors to generate electricity, and the land required to permanently dispose of the radioactive and nonradioactive wastes. Some of these resources could be retrieved and reused at the end of the license renewal term. For example, some reactor equipment can be used at other reactors or can be decontaminated and released for recycling or restricted or unrestricted use by others. However, some of the equipment and irradiated components that might be replaced during the license renewal term might not be reused or recycled and therefore need to be permanently disposed of. In addition, the fossil fuels used by power plants would be permanently lost. Most of the water used by power plants relying on once-through cooling is returned to the surface water bodies that supply the cooling water. The relatively small portion of the water that evaporates to the air would be lost to the local water bodies and the region but would be returned to the environment as part of the hydrologic cycle, potentially within another watershed. For closed-cycle cooling systems, a much larger percent of the water used for cooling would be lost to evaporation, but that, too, would be returned as part of the hydrologic cycle.

The most significant irreversible and irretrievable commitment of resources related to nuclear power plant operations during the license renewal term would be the nuclear fuel used to generate electricity and the land used to dispose and store wastes, including spent nuclear fuel generated during the license renewal term. The treatment, storage, and disposal of LLW, hazardous waste, and nonhazardous waste would require the irretrievable commitment of energy and fuel and could result in the irreversible commitment of space in disposal facilities. Some of the land used for the disposal of LLW may be available for other uses in a few hundred years because of the nearly complete decay of short-lived radionuclides in LLW, but most of the land used for the disposal of some mixed or hazardous wastes could be permanently lost to other users.

The irreversible and irretrievable commitment of resources would not be the same for all nuclear power plants and would depend on the specific characteristics of the power plant and its resource needs. This commitment is evaluated in plant-specific SEISs.

The implementation of any of the replacement power alternatives would entail the irreversible and irretrievable commitment of energy, water, chemicals, and, in some cases, fossil fuels. These resources would be committed over the entire life cycle of the power plant from construction, operation, and decommissioning, and would essentially be unrecoverable.

Energy expended would be in the form of fuel for equipment, vehicles, and power plant operations and electricity for power plant construction and facility operations. Electricity and fuels would be purchased from offsite commercial sources. Water would be obtained from existing water supply systems. These resources are generally available, and the amounts required are not expected to deplete available supplies or exceed available system capacities.

The irreversible and irretrievable commitment of material resources are the materials that cannot be recovered or recycled, materials that are rendered radioactive and/or cannot be decontaminated, and materials consumed or reduced to unrecoverable forms of waste. However, none of the resources used by these alternative replacement power generating facilities is in short supply, and, for the most part, readily available.

Various materials and chemicals, including acids and caustics, would be required to support operations activities. These materials would be derived from commercial vendors, and their consumption is not expected to affect local, regional, or national supplies.

Independent spent fuel storage installation (ISFSI): An ISFSI is designed and constructed for the interim storage of spent nuclear fuel and other radioactive materials associated with spent fuel storage. ISFSIs may be located at the site of a nuclear power plant or at another location. The most common design for an ISFSI, at this time, is a concrete pad with dry casks containing spent fuel bundles. ISFSIs are used by operating plants that require increased spent fuel storage capability because their spent fuel pools have reached capacity.

In situ: In its original place.

Integrated gasification combined cycle (IGCC) technology: An energy generation technology in which coal, water, and oxygen are fed to a gasifier, which produces syngas. This medium-Btu gas is cleaned (particulates and sulfur compounds removed) and fed to a gas turbine. The hot exhaust of the gas turbine and heat recovered from the gasification process is routed through a heat-recovery generator to produce steam, which drives a steam turbine to produce electricity.

Internal dose: That portion of the dose equivalent received from radioactive material taken into the body.

Ionizing radiation: Any radiation capable of displacing electrons from atoms or molecules, thereby producing ions. Some examples are alpha, beta, gamma, x-rays, neutrons, and ultraviolet light. High doses of ionizing radiation may produce severe skin or tissue damage.

Isotopic enrichment: A process by which the relative abundance of the isotopes of a given element is altered, thus producing a form of the element that has been enriched in one particular isotope and depleted in its other isotopic forms.

Landfill gas: Gas that is generated by decomposition of organic material at landfill disposal sites. The average composition of landfill gas is approximately 50 percent methane and 50 percent carbon dioxide and water vapor by volume. The methane percentage, however, can vary from 40 to 60 percent, depending on several factors including waste composition (e.g., carbohydrate and cellulose content). The methane in landfill gas may be vented, flared, or combusted to generate electricity or heat, or injected into a pipeline for combustion elsewhere.

Leachate: The liquid that has percolated through the soil or other medium.

License renewal: Renewal of the operating license of a nuclear power plant.

License renewal term: That period of time past the original or current license term for which the renewed license is in force. Although the length of license renewal terms can vary, they cannot exceed 20 years.

Appendix E

Environmental Impact of Postulated Accidents

E.1 Introduction

Chapter 5 of the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants (*GEIS), Volumes 1 and 2 (NRC 1996, 1999)[a] assessed the impacts of postulated accidents at nuclear power plants on the environment. The postulated accidents included design-basis accidents and severe accidents (e.g., those with core damage). The impacts considered included:

- Dose and health effects of accidents (Sections 5.3.3.2 through 5.3.3.4);
- Economic impacts of accidents (Section 5.3.3.5); and
- Effect of uncertainties on the results (Section 5.3.4).

The estimated impacts were based on the analysis of severe accidents at 28 nuclear power plant sites[b] as reported in the environmental impact statements (EISs) and/or final environmental statements (FESs) prepared for each of the 28 plants in support of their operating licenses. With few exceptions, the severe accident analyses were limited to consideration of reactor accidents caused by internal events. The 1996 GEIS addressed the impacts from external events qualitatively.[c] The severe accident analysis for the 28 sites was extended to the remainder of plants whose EISs did not consider severe accidents (since such analyses were not required at the time the other plants' EISs were prepared). The estimates of environmental impact contained in the 1996 GEIS used 95th percentile upper confidence bound (UCB) estimates whenever available. This approach provides conservatism to cover

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "1996 GEIS" include the original GEIS and Addendum 1.

(b) The 28 sites are listed in Table 5.1 of the 1996 GEIS. There are a total of 44 units included in this list (at the 28 sites), but 4 of these units never operated (Grand Gulf 2, Harris 2, Perry 2, and Seabrook 2). For the purpose of this appendix, this list will be referred to as containing 28 nuclear power plants, but when mean values are calculated for this subset of nuclear power plants, all 40 units that operated are considered.

(c) See Section 5.3.3.1 of the 1996 GEIS, including a brief discussion of the external event risk assessments conducted by the staff prior to 1996, which included assessments for Zion 1 & 2, Indian Point 2 & 3, Limerick 1 & 2, Surry 1, Peach Bottom 2, and Millstone 3.

uncertainties, as described in Section 5.3.3.2.2 of the 1996 GEIS. The 1996 GEIS concluded that the probabilistically weighted impacts were small compared to other risks to which the populations surrounding nuclear power plants are routinely exposed.

The focus of this revision is on severe accidents since the impacts from design-basis accidents are SMALL and, as stated in Section E.3 of this revision, the U.S. Nuclear Regulatory Commission's (NRC's) assessment remains unchanged. Since the NRC's understanding of severe accident risk has evolved since issuance of the 1996 GEIS, this appendix assesses more recent information on severe accidents that might alter the conclusions in Chapter 5 of the 1996 GEIS. This revision considers how these developments would affect the conclusions in the 1996 GEIS and provides comparative data where appropriate. This revision does not attempt to provide new quantitative estimates of severe accident impacts. In addition, the revision only covers one initial license renewal period for each plant (as did the 1996 GEIS). Thus, the population projections, meteorology, and exposure indices used in the 1996 GEIS are assumed to remain unchanged for purposes of this analysis.

Finally, the format of this appendix follows the same format as used in Chapter 5 of the 1996 GEIS, including a discussion on uncertainties and severe accident mitigation alternatives (SAMAs).

E.2 Plant Accidents

A general description of plant accidents is contained in Section 5.2 of the 1996 GEIS. This description covered:

- The general characteristics of accidents;
- Fission product characteristics;
- Meteorological considerations;
- Exposure pathways;
- Adverse health effects;
- Avoiding adverse health effects;
- Accident experience and observed impacts;

- Mitigation of accident consequences; and

- Emergency preparedness.

This description is still valid and thus remains unchanged. Section 5.2 of the 1996 GEIS also mentions that as of 1990, there have been approximately 1,300 reactor-years of experience to support the safety of U.S. nuclear power plants. As with any technology, experience generally leads to improved plant performance and public safety. As of 2011, there has been approximately an additional 2,000 reactor-years of experience in the United States. This additional experience has contributed to improved plant performance (e.g., as measured by trends in plant-specific performance indicators), a reduction in operating events, and lessons learned that improve the safety of all of the operating nuclear power plants. Other examples of items contributing to improved safety include:

- Implementation of plant improvements identified through the Individual Plant Examination (IPE) and Individual Plant Examination: External Events (IPEEE) programs (e.g., strengthening of seismic supports; enhanced fire brigade training) (NRC 2003);

- Identification of specific aging mechanisms (e.g., cables; irradiation-assisted stress corrosion cracking) and development of programs to monitor and control these mechanisms (NRC 2001c);

- NRC staff actions on generic safety issues (e.g., Generic Safety Issue 191 on sump performance) (NRC 2008e); and

- Implementation of the NRC's Interim Compensatory Measures (ICMs) Order following the September 2001 terrorist attacks.[d]

Thus, the performance and safety record of nuclear power plants operating in the United States continues to improve. This is also confirmed by analysis which indicates that, in many cases, improved plant performance and design features have resulted in reductions in initiating event frequency, core damage frequency, and containment failure frequency.[e]

(d) The safety evaluations (SEs) for the operating license amendments associated with implementation of Section B.5.b. of Commission Order EA-02-026 provide background related to the implementation of particular portions of the ICMs. As an example, the reader is referred to the SE associated with Brunswick Steam Electric Plant, Units 1 and 2 (NRC 2007a).

(e) This statement is based on industry performance data provided in the NRC's *2007-2008 Information Digest* (NRC 2007b) and on the NRC's website (NRC 2008c), as well as information contained in Chapter 5 of site-specific EISs (the NUREG-1437 series of supplements).

E.2.1 Fukushima Earthquake and Tsunami

On March 11, 2011, a massive earthquake off the east coast of Honshu, Japan, produced a devastating tsunami that struck the coastal town of Fukushima. The six-unit Fukushima Dai-ichi nuclear power plant was directly impacted by these events. The resulting damage caused the failure of several of the units' safety systems needed to maintain cooling water flow to the reactors. As a result of the loss of cooling, the fuel overheated, and there was a partial meltdown of the fuel contained in several of the reactors. Damage to the systems and structures containing reactor fuel resulted in the release of radioactive material to the surrounding environment.

In response to the earthquake, tsunami, and resulting reactor accidents at Fukushima Dai-ichi (hereafter referred to as the "Fukushima events"), the Commission directed the staff to convene an agency task force of senior leaders and experts to conduct a methodical and systematic review of the relevant NRC regulatory requirements, programs, and processes, including their implementation, and to recommend whether the agency should make near-term improvements to its regulatory system. As part of the short-term review, the task force concluded that, while improvements are expected to be made as a result of the lessons learned from the Fukushima events, the continued operation of nuclear power plants and licensing activities for new plants do not pose an imminent risk to public health and safety (NRC 2011).

During the time that the task force was conducting its review, groups of individuals and non-governmental organizations petitioned the Commission to suspend all licensing decisions in order to conduct a separate, generic National Environmental Policy Act (NEPA) analysis to determine whether the Fukushima events constituted "new and significant information" under NEPA that must be analyzed as part of environmental reviews. The Commission found the request premature and noted, "In short, we do not know today the full implications of the [Fukushima] events for U.S. facilities."(f) However, the Commission found that if "new and significant information comes to light that requires consideration as part of the ongoing preparation of application-specific NEPA documents, the agency will assess the significance of that information, as appropriate."(g) The Federal courts of appeal and the Commission have interpreted NEPA such that an EIS must be updated to include new information only when that

(f) *Union Electric Co. d/b/a Ameren Missouri* (Callaway Plant, Unit 2), CLI-11-05, 74 NRC141, 167 (Sept. 9, 2011).
(g) *Id.*

new information provides "a seriously different picture of the environmental impact of the proposed project from what was previously envisioned."[(h)]

In the context of the GEIS, the Fukushima events are considered a severe accident (i.e., a type of accident that may challenge a plant's safety systems at a level much higher than expected) and more specifically, a severe accident initiated by an event external to the plant. The 1996 GEIS concluded that risks from severe accidents initiated by external events (such as an earthquake) could have potentially high consequences but found that external events are adequately addressed through a consideration of a severe accident initiated by an internal event (such as a loss of cooling water). Therefore, an applicant for license renewal need only analyze the environmental impacts from an internal event in order to adequately characterize the environmental impacts from either type of event. Prior to the Fukushima events, this GEIS examined more recent and up-to-date information regarding external events and concluded that the analysis in the 1996 GEIS remains valid.

As of the publication date of this GEIS, the NRC's evaluation of the consequences of the Fukushima events is ongoing. As such, the NRC will continue to evaluate the need to make improvements to existing regulatory requirements based on the task force report and additional studies and analyses of the Fukushima events as more information is learned. To the extent that any revisions are made to NRC regulatory requirements, they would be made applicable to nuclear power reactors regardless of whether or not they have a renewed license. Therefore, no additional analyses have been performed in this GEIS as a result of the Fukushima events. In the event that the NRC identifies information from the Fukushima events that constitutes new and significant information with respect to the environmental impacts of license renewal, the NRC will discuss that information in its site-specific supplemental EISs (SEISs) to the GEIS, as it does with all such new and significant information.

E.3 Accident Risk and Impact Assessment

The environmental impacts from design-basis accidents and severe accidents are assessed in Sections 5.3.2 and 5.3.3 of the 1996 GEIS, respectively. As stated in Section 5.3.2, the environmental impact from design-basis accidents was assessed in the individual plant-specific EISs at the time of the initial license application review. Since the licensee is required to

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(h) *Id*. at 167-68 *quoting Hydro Resources, Inc.* (2929 Coors Road, Suite 101, Albuquerque, NM 87120), CLI-99-22, 50 NRC 3, 14 (1999) (citing *Marsh v. Oregon Natural Resources Council*, 490 U.S. 360, 373 (1989)). The Commission also noted that it can modify a facility's operating license outside of a renewal proceeding and made clear that "it will use the information from these activities to impose any requirement it deems necessary, irrespective of whether a plant is applying for or has been granted a renewed operating license." *Id.* at 164 *quoting Pilgrim & Indian Point:* Entergy's Answer Opposing Petition to Suspend Pending Licensing Proceedings (May 2, 2011) at 3.

maintain the plant within acceptable design and performance criteria, including during any license renewal term, these impacts are not expected to change. Therefore, additional assessment of the environmental impacts from design-basis accidents is not necessary, and the bulk of the 1996 GEIS evaluation focused on the environmental impact of severe accidents.

To assess the impacts from the airborne pathway, the 1996 GEIS relied on severe accident analyses provided in the EISs for the more recent sites. Table 5-1 in the 1996 GEIS lists the 28 nuclear power plants that included severe accident analyses in their plant-specific EISs. These plant-specific EISs used site-specific meteorology, land topography, population distributions, and offsite emergency response parameters, along with generic or plant-specific source terms, to calculate offsite health and economic impacts. The offsite health effects included those from airborne releases of radioactive material and contamination of surface water and groundwater.

The 1996 GEIS used the environmental impact information from the 28 plant-specific EISs and a metric called the exposure index to (1) scale up the radiological impact of severe accidents on the population due to demographic changes from the time the original EIS[i] was done until the year representing the mid-license renewal period and (2) estimate the severe accident environmental impacts for the earlier plants (whose EISs did not include a quantitative assessment of severe accidents). The exposure index method uses the projected population distribution around each nuclear power plant site at the middle of its license renewal period and meteorology data for each site to provide a measure of the degree to which the population would be exposed to the release of radioactive material resulting from a severe accident (i.e., the exposure index method weights the population in each of 16 sectors around a nuclear power plant by the fraction of time the wind blows in that direction on an annual basis). The exposure index metric was also used to project economic impacts at the mid-year of the license renewal period. A more detailed description of the exposure index method is contained in Appendix G of the 1996 GEIS. The use of the exposure index method remains valid.

Since 1996, developments in plant operation and accident analysis have taken place that could affect the assumptions made in the 1996 GEIS. These changes are grouped into the following areas and are each covered in the indicated section of this revision:

- Internal event risk (Section E.3.1);
- External event risk (Section E.3.2);

(i) The term “original EIS” describes an EIS issued by the NRC that is associated with the issuance of a plant’s initial operating license. This term is used in this appendix to differentiate it from an EIS prepared in conjunction with a license renewal environmental review.

- Updates in the quantification of accident source terms (Section E.3.3);
- Increases in licensed reactor power levels, i.e., power uprates (Section E.3.4);
- Increases in fuel burnup levels (Section E.3.5);
- Consideration of reactor accidents at low power and shutdown conditions (Section E.3.6);
- Consideration of accidents in spent fuel pools (Section E.3.7); and
- The BEIR VII report on the risk of fatal cancers posed by exposure to radiation (Section E.3.8).

Sections discussing uncertainties, SAMAs, and conclusions are also provided.

As discussed in the Section 5.3.3.1 of the 1996 GEIS, the environmental impacts from security-related events were not considered in that document. As stated, these types of events are addressed via deterministic criteria in Title 10, Part 73, of the *Code of Federal Regulations* (10 CFR Part 73), rather than by risk assessments. The regulatory requirements under 10 CFR Part 73 provide reasonable assurance that the risk from sabotage is small. This section goes on to state:

> Although the threat of sabotage events cannot be accurately quantified, the Commission believes that acts of sabotage are not reasonably expected. Nonetheless, if such events were to occur, the Commission would expect that resultant core damage and radiological releases would be no worse than those expected from internally initiated events.

The NRC continues to take this position. As a result of the terrorist attacks of September 11, 2001, the NRC conducted a comprehensive review of the agency's security program and made further enhancements to security at a wide range of NRC-regulated facilities. These enhancements included significant reinforcement of the defense capabilities for nuclear facilities, better control of sensitive information, enhancements in emergency preparedness to further strengthen NRC's nuclear facility security program, and implementation of mitigating strategies to deal with postulated events potentially causing loss of large areas of the plant due to explosions or fires, including those that an aircraft impact might create. These measures are outlined in greater detail in NUREG/BR-0314 (NRC 2004), NUREG-1850 (NRC 2006a), and Sandia National Laboratory's "Mitigation of Spent Fuel Loss-of-Coolant Inventory Accidents and Extension of Reference Plant Analyses to Other Spent Fuel Pools" (NRC 2006b).

The NRC routinely assesses threats and other information provided by a variety of Federal agencies and sources. The NRC also ensures that licensees meet appropriate security-level requirements. The NRC will continue to focus on prevention of terrorist acts for all nuclear facilities and will not focus on site-specific evaluations of speculative environmental impacts resulting from terrorist acts. While these are legitimate matters of concern, the NRC will continue to address them through the ongoing regulatory process as a current and generic regulatory issue that affects all nuclear facilities and many of the activities conducted at nuclear facilities. The issue of security and risk from malevolent acts at nuclear power facilities is not unique to facilities that have requested a renewal of their licenses (NRC 2006a).

Malevolent acts remain speculative and beyond the scope of a NEPA review. NEPA requires that there be a "reasonably close causal relationship" between the federal agency action and the environmental consequences. The environmental impact of a terrorist attack is too far removed from the natural, or expected, consequences of a license renewal action to warrant consideration under NEPA. However, as noted above, in the event of a terrorist attack, the consequences of such an attack would be no worse than an internally initiated severe accident, which has already been analyzed.

In a decision dated June 2, 2006, *San Luis Obispo Mothers for Peace v. NRC*, 449 F.3d 1016, 1028 (9th Cir. 2006) the U.S. Court of Appeals for the Ninth Circuit held that NRC could not categorically refuse to consider the consequences of a terrorist attack under NEPA and remanded the case to NRC. On remand, the Commission adjudicated the intervenors' claim that the NRC staff had not adequately assessed the environmental consequences of a terrorist attack on the Diablo Canyon Power Plant's proposed facility for storing spent nuclear fuel in dry casks. *See, Pacific Gas & Electric Co.,* (Diablo Canyon Power Plant Independent Spent Fuel Storage Installation), CLI-08-26, 68 NRC 509 (2009). The Commission ultimately determined that an EIS was not required in order to address land contamination and latent health effect issues (Diablo Canyon, CLI-08-26, 68 NRC at 521). Further, the Commission concluded that the staff's final, supplemental environmental assessment and finding of no significant impact, the adjudicatory record of the case, and its supervisory review of the non-public information underlying portions of the staff's analyses, satisfied the agency's NEPA obligations. *Id.* 525-26. The staff had found that even the most severe, plausible terrorist attack of those examined would not cause immediate or latent health effects. The staff also found that such an attack was improbable, but if one occurred, the likelihood of significant radioactive release was very low because the nature of the Diablo Canyon casks and site. *Id.* at 521. The U.S. Court of Appeals for the Ninth Circuit upheld the Commission's determination on appeal. *San Luis Obispo Mothers for Peace v. NRC*, 645 F.3d 1109, 1120-21 (9th Cir. 2011).

The Commission stated that it will adhere to the Ninth Circuit decision when considering licensing actions for facilities subject to the jurisdiction of that Circuit. *See Pacific Gas and Electric Co., (Diablo Canyon Power Plant Independent Spent Fuel Storage Installation*), CLI-07-11, 65 NRC 118 (2007). However, the Commission decided against applying that holding to all licensing proceedings nationwide. In one such proceeding, *Amergen Energy Co. LLC* (Oyster Creek Nuclear Generating Station), CLI-07-8, 65 NRC 124, 128-29 (2007), the New Jersey Department of Environmental Protection contended that NEPA requires an analysis of a terrorist attack. The NRC found that NEPA "imposes no legal duty on the NRC to consider intentional malevolent acts" because such acts are "too far removed from the natural or expected consequences of agency action." *Id.* at 129 (quoting the Board decision). The NRC also found that a terrorism review would be redundant because (1) "the NRC has undertaken extensive efforts to enhance security at nuclear facilities," which it characterized as the best mechanism to protect the public; *id.* at 130; (2) the GEIS had addressed the issue and concluded that "the core damage and radiological release from [terrorist] acts would be no worse than the damage and release to be expected from internally initiated events." On appeal, the Third Circuit agreed with the NRC and denied the petition. *See NJDEP v. NRC and Amergen Energy Co, LLC,* (Case No. 07-2271), 561 F.3rd 132 (3rd Cir. 2009). The Court found that, "the NRC correctly concluded that the relicensing of Oyster Creek does not have a 'reasonably close causal relationship' with the environmental effects that would be caused in the event of a terrorist attack." 561 F.3d at 143.

The Third Circuit disagreed with the Ninth Circuit's application of the relevant Supreme Court decisions. Instead, as the Commission had originally held, the Third Circuit concluded that the issuance of a facility license—here, the issuance of the 20-year extension for the Oyster Creek license—would not be the "proximate cause" of a terrorist attack on the facility.

Moreover, the Third Circuit noted that the GEIS for License Renewal had reviewed the possible impacts of a sabotage event, which is a form of terrorism. The GEIS found that the consequences of a sabotage event would be no worse than those expected from an internally initiated severe accident. The Third Circuit noted that the petitioner in the case before it (the State of New Jersey) had failed to demonstrate that the results of a terrorist attack would be any different than those of a severe accident, which had already been analyzed. The Third Circuit also noted that the NRC had prepared a site-specific EIS addressing the mitigation of severe accidents at Oyster Creek. As a result, the Third Circuit found that, even if the Commission were required to analyze the impacts of a terrorist attack, the NRC had prepared both generic and site-specific analyses of the impacts of a terrorist attack at Oyster Creek, and that the Petitioner had not shown that the NRC could evaluate the risks more meaningfully than it had already done.

Subsequent to the Third Circuit's determination, the Commission overturned the Board's decision to admit a NEPA terrorism contention in the Diablo Canyon License Renewal proceeding, a facility located in the Ninth Circuit. *Pacific Gas & Electric Co.* (Diablo Canyon Nuclear Power Plant), CLI-11-11, 74 NRC (slip op. at 40) (2011). The Commission reaffirmed that "the staff's determination in the GEIS that the environmental impacts of a terrorist attack were bounded by those resulting from internally-initiated events, was sufficient to address the environmental impacts of terrorism." *Id*.

In sum, the Commission has found that the issuance of a facility license is not the "proximate cause" of a terrorist attack at that facility. Thus, it is not required to prepare an EIS discussion on the potential impacts of a terrorist attack. However, due to the decision of the Ninth Circuit, the NRC will prepare an analysis of the environmental impacts of a terrorist attack for licensing actions of facilities within the geographical boundaries of the Ninth circuit. In addition, the Third Circuit has held that the GEIS for License Renewal constitutes such an analysis for license renewals.

E.3.1 Impact of New Information on Accidents Initiated by Internal Events

With few exceptions, the severe accident analyses formulating the basis for the 1996 GEIS were limited to consideration of reactor accidents caused by internal events. The GEIS addressed the impacts from external events qualitatively, and external events are covered in more detail in Section E.3.2 of this revision. The impacts from the 1996 GEIS were based on the original license EISs for the 28 nuclear power plant sites listed in Table 5.1 of the GEIS. The source terms and their likelihood used in the plant-specific original EISs to calculate the airborne pathway environmental impacts of accidents were, in turn, usually based upon information contained in NUREG-0773 (NRC 1982). NUREG-0773 is an update of the original Reactor Safety Study (NRC 1975). These source terms and frequencies were used along with site-specific meteorology, population distributions, and emergency planning characteristics to calculate the airborne pathway environmental impacts. These EISs were issued in the 1981 to 1986 time frame. Thus, while the GEIS was published in 1996, it was primarily based on information from the 1980s.

Since the publication of NUREG-0773, many additional studies have been completed on the likelihood and consequences of reactor accidents initiated by internal events at full power. These studies include NUREG-1150 (NRC 1990b), NUREG/CR-5305 (NRC 1992), and licensee responses to Generic Letter 88-20, Supplement 1 (i.e., the IPE program). Licensees have further developed their IPE-vintage probabilistic risk assessment (PRA) models to support risk-informed licensing actions, including license renewal SAMA analysis. In addition, the NRC has developed standardized plant analysis risk (SPAR) models for all operating plants which can be used to calculate core damage frequencies (CDFs) for internal events.

The purpose of this section is to assess how results from more up-to-date internal event information compare to those on which the 1996 GEIS was based. The evaluation contained in this section compares the CDFs that formed the basis for the 1996 GEIS, and offsite doses directly from the 1996 GEIS, to the newer information. The comparison is done for pressurized water reactors (PWRs) and boiling water reactors (BWRs) and covers each of the plants listed in Table 5.1 of the 1996 GEIS. Changes in source terms (i.e., the quantity, form, and timing of radioactive material released to the environment) are assessed in Section E.3.3.

E.3.1.1 Airborne Pathway Impacts

As a first step in the comparison, the CDFs from the original EISs are compared to the CDFs reported in the plant-specific IPEs for the PWRs and BWRs considered by the 1996 GEIS. Tables E-1 and E-2 show these comparisons. As can be seen in Tables E-1 and E-2, for many plants, the IPE CDFs are smaller than those from the original EISs, particularly for BWRs. The mean of the IPE CDFs listed in Tables E-1 and E-2 are lower than the corresponding mean EIS CDF by 30 percent for PWRs and by more than a factor of 3 for BWRs. Accordingly, the likelihood of an accident that leads to core damage would be comparable to or less for PWRs, and significantly less for BWRs, than that used as the basis for the 1996 GEIS.

Additional comparisons can be made using information from NUREG-0773 (NRC 1982), the original EISs, NUREG-1150 (NRC 1990b), the IPEs, NUREG/CR-5305 (NRC 1992), recent analysis using SPAR models, and license renewal applications received to date. These comparisons are shown in Table E-3. In general, the Level 1 (CDF) results are comparable to or less than the corresponding Level 1 information from the GEIS. Furthermore, the newer estimates (license renewal and SPAR) are up to a factor of 2.5 lower than the mean IPE CDFs from Tables E-1 and E-2.

The comparison of Level 3 (offsite consequences) information is made difficult due to differences in the values reported between older and newer assessments. Older assessments tended to provide mean and/or upper bound population doses for the entire region surrounding the nuclear power plant (as far as 1000 mi). Newer assessments tend to provide mean values within 50 mi. NUREG-1150 provided distributions for both within 50 mi and the site region and is used as a bridge in this comparison.

The mean of population dose results from the original EISs of the 28 sites that considered severe accidents are a factor of 2 to 4 lower than the mean of the plant-specific upper bound estimates used in the 1996 GEIS for those same 28 sites. The mean population doses from NUREG-1150 (site region results) are, in turn, a factor of 10 to 100 less than the original EIS mean value. In actuality, the difference is even larger, because the NUREG-1150 estimate covers a larger area (site region for NUREG-1150 versus 150 mi for the EISs). The NUREG-1150 results for a 50-mi radius are a factor of 4 to 10 lower than the site region results. The mean of license renewal results (for a 50-mile region) are somewhat higher than the mean results reported in NUREG-1150 for a 50-mile region, but are still well below the population dose values reported in the original environmental impact statements for the 28 sites and used in the 1996 GEIS.

Table E-1. PWR Internal Event (Full Power) Comparison

Plant	Original EIS Estimated CDF[a]	IPE CDF[b]
Beaver Valley 2	1.0×10^{-4}/yr	1.9×10^{-4}/yr
Braidwood 1, 2	1.0×10^{-4}/yr	2.7×10^{-5}/yr
Byron 1, 2	4.8×10^{-5}/yr	3.1×10^{-5}/yr
Callaway 1	4.8×10^{-5}/yr	5.9×10^{-5}/yr
Catawba 1, 2	4.8×10^{-5}/yr	5.8×10^{-5}/yr
Comanche Peak 1, 2	4.8×10^{-5}/yr	5.7×10^{-5}/yr
Shearon Harris 1	4.8×10^{-5}/yr	7.0×10^{-5}/yr
Indian Point 2, 3	3.5×10^{-4}/yr, 3.4×10^{-4}/yr	3.1×10^{-5}/yr, 4.4×10^{-5}/yr
Millstone 3	2.0×10^{-4}/yr	5.6×10^{-5}/yr
Palo Verde 1, 2, 3	4.8×10^{-5}/yr	9.0×10^{-5}/yr
San Onofre 2, 3	4.8×10^{-5}/yr	3.0×10^{-5}/yr
Seabrook 1	4.8×10^{-5}/yr	6.1×10^{-5}/yr[c]
South Texas 1, 2	4.4×10^{-5}/yr	4.3×10^{-5}/yr
St. Lucie 2	4.8×10^{-5}/yr	2.6×10^{-5}/yr
Summer 1	4.9×10^{-5}/yr	2.0×10^{-4}/yr
Vogtle 1, 2	1.0×10^{-4}/yr	4.9×10^{-5}/yr
Waterford 3	4.8×10^{-5}/yr	1.8×10^{-5}/yr
Wolf Creek 1	4.8×10^{-5}/yr	4.2×10^{-5}/yr
Mean value	8.4×10^{-5}/yr	5.9×10^{-5}/yr
Median value	4.8×10^{-5}/yr	4.9×10^{-5}/yr

(a) Obtained by summing individual atmospheric release sequences, including intact containment sequences.
(b) Source: NRC 2003, unless otherwise noted.
(c) Obtained from the licensee's IPEEE submittal.

To summarize, the general contribution to decreased estimated doses are a factor of 2 to 4 simply due to the conservatism built into the 1996 GEIS values. An additional decrease in estimated doses of 10 to 100 is seen when comparing the EIS results to the NUREG-1150 results and a factor of 5 to 33 when comparing the EIS results to license renewal SAMA results.

E.3.1.2 Other Pathway Impacts

Any change in the likelihood of accidents that release substantial amounts of radioactive material to the environment not only affects the airborne pathway, but also the surface water and groundwater pathways and the resulting economic impacts from any pathway. The information in Tables E-1, E-2, and E-3 indicate that the likelihood and impacts of airborne pathway releases is smaller than that used in the 1996 GEIS. Since this pathway directly

Table E-2. BWR Internal Event (Full Power) Comparison

Plant	Original EIS Estimated CDF[a]	IPE CDF[b]
Clinton 1	2.4×10^{-5}/yr	2.7×10^{-5}/yr
Fermi 2	2.4×10^{-5}/yr	5.7×10^{-6}/yr
Grand Gulf 1	2.4×10^{-5}/yr	1.7×10^{-5}/yr
Hope Creek	1.0×10^{-4}/yr	4.6×10^{-5}/yr
Limerick 1 ,2	8.9×10^{-5}/yr	4.3×10^{-6}/yr
Nine Mile Point 2	1.1×10^{-4}/yr	3.1×10^{-5}/yr
Perry 1	2.4×10^{-5}/yr	1.3×10^{-5}/yr
River Bend	9.5×10^{-5}/yr	1.6×10^{-5}/yr
Susquehanna 1, 2	2.4×10^{-5}/yr	5.6×10^{-7}/yr[c]
WNP-2[d]	2.4×10^{-5}/yr	1.8×10^{-5}/yr
Mean value	5.4×10^{-5}/yr	1.5×10^{-5}/yr
Median value	2.4×10^{-5}/yr	1.45×10^{-5}/yr

(a) Obtained by summing individual atmospheric release sequences, including intact containment sequences.
(b) Source: NRC 2003, unless otherwise noted.
(c) Revised 1998 IPE; obtained from NUREG-1437, Supp. 35, Appendix G.
(d) WNP-2 = Washington Nuclear Project 2 (i.e., Columbia).

affects the surface water pathway, it is reasonable to conclude that the likelihood of the surface pathway impacts would also be smaller and would continue to be bounded by the airborne pathway. The decreased likelihood of any pathway impacts would indicate the reduced likelihood of any subsequent economic impacts. This assumption is consistent with the results of the 1996 GEIS.

Furthermore, some information is available regarding basemat melt-through sequences, which could impact the groundwater pathway:

- WASH-1400 (NRC 1975) used a frequency of 4×10^{-5}/yr for basemat melt-through sequences;
- NUREG-0773 (NRC 1982) used a generic frequency of 3×10^{-5}/yr and a site-specific frequency of 1.1×10^{-5}/yr for Indian Point Units 2 and 3;
- NUREG-1150 (NRC 1990b) calculated the basemat melt-through frequencies for Surry and Sequoyah to be 2.4×10^{-6}/yr and 1×10^{-5}/yr, respectively;

Table E-3. Comparisons with Other Risk Information (Full Power Internal Events)

Reactor Type	Comparison	Information Source	CDF (mean/point estimate)	Person-Rem per Year (Mean, except as noted) Region[a]	50-mi
PWR	GEIS Basis	NUREG-0773[b]	6×10^{-5}/yr		
		Original EIS[c]	8.4×10^{-5}/yr	932	
		1996 GEIS[c]		2,200[d]	
	Update	NUREG-1150 Plants			
		- Surry	4×10^{-5}/yr	~30	~6
		- Sequoyah	5.6×10^{-5}/yr	~80	~10
		IPE			
		- Catawba	5.8×10^{-5}/yr		15.66
		- McGuire	4×10^{-5}/yr		4.6
		- Surry	1.25×10^{-4}/yr		
		- Sequoyah	1.7×10^{-4}/yr		
		License Renewal[e]	3.9×10^{-5}/yr		18.1
		SPAR (v3.45)[c]	2.3×10^{-5}/yr		
BWR	GEIS Basis	NUREG-0773[b]	2×10^{-5}/yr		
		Original EIS[c]	5.4×10^{-5}/yr	577	
		1996 GEIS[c]		2,720[d]	
	Update	NUREG-1150 Plants			
		- Grand Gulf	4×10^{-6}/yr	~5	~0.5
		- Peach Bottom	4.4×10^{-6}/yr	~30	~7
		NUREG/CR-5305			
		- LaSalle	4×10^{-5}/yr	1,500[f]	66[e]
		IPE			
		- Peach Bottom	5.5×10^{-6}/yr		
		- LaSalle	4.7×10^{-5}/yr		
		- Grand Gulf	1.7×10^{-5}/yr		

Reactor Type	Comparison	Information Source	CDF (mean/point estimate)	Person-Rem per Year (Mean, except as noted)	
				Region[a]	50-mi
		License Renewal[e]	1.4×10^{-5}/yr		14.5
		SPAR (v3.45)[b]	8×10^{-6}/yr		

(a) For the EISs and GEIS, the employed distance is 150 mi; for NUREG-1150 and NUREG/CR-5305, the employed distance is 1,000 mi.
(b) Based on Table 22 (CDF) of that document; PWR CDF cited is for Surry and BWR corresponds to Peach Bottom.
(c) Values are for those plants listed in Tables E-1 and E-2.
(d) Note that this is the mean of the distribution of 95th percent UCB values.
(e) Mean values for all plants that have applied for license renewal as of August 2008; in a few cases (Beaver Valley, Calvert Cliffs, Ginna, and Nine Mile Point), the site-specific population dose values used included both internal and external events.
(f) Includes both internal and external events.

- A sample of IPE results showed basemat melt-through frequencies ranging from 1×10^{-6}/yr to 4×10^{-6}/yr; and

- A sample of license renewal application results showed basemat melt-through frequencies ranging from 2×10^{-7}/yr to 6×10^{-6}/yr.

For the 1996 GEIS, a conservative value of 1×10^{-4}/yr was used (see Section 5.3.3.4 of the 1996 GEIS), which is higher than any of the values cited above. As such, it is concluded that the basemat melt-through frequencies used in the 1996 GEIS to assess the groundwater pathway are bounding.

For BWRs, no quantitative basemat melt-through information was available. It is expected that for BWRs, containment failure by overpressure would occur before basemat melt-though. In addition, if basemat melt-through sequences do occur, their frequency would be less than that for PWRs due to the lower CDFs for BWRs.

E.3.1.3 Conclusion

The PWR and BWR accident frequencies that form the basis for the environmental impacts shown in the 1996 GEIS are, in most cases, comparable to or higher than the updated accident frequencies shown in Tables E-1, E-2, and E-3. In addition, the population dose estimates presented in Table E-3 demonstrate the conservatism in the 1996 GEIS values, both from the standpoint of reduced population dose from more recent estimates and the conservatism built into the GEIS methodology.

E.3.2 Impact of Accidents Initiated by External Events

The 1996 GEIS included a qualitative assessment of the environmental impacts of accidents initiated by external events (see Section 5.3.3.1 of that document). The purpose of this section is to consider updated information regarding potential external event impacts. The sources of information used in this assessment are (1) NUREG-1150 (NRC 1990b) (and the supporting documentation in NUREG/CR-4551 [NRC 1990a]), which assessed seismic and fire events for two plants (Surry and Peach Bottom); (2) NUREG/CR-5305 (NRC 1992), which analyzed the risk from seismic and fire events for one plant (LaSalle); and (3) the results from the IPEEE program, as documented in NUREG-1742 (NRC 2003). The IPEEE program was initiated in the early 1990s and required all operating plants in the United States to do an assessment to identify vulnerabilities to severe accidents initiated by external events and report the results to the NRC, along with any identified improvements and/or corrective actions. NUREG-1742 documents the perspectives derived from the technical reviews of the IPEEE results.

Typically, the external events that contribute the most to plant risk are seismic and fires. In some cases, high winds, floods, and tornados may contribute to plant risk; however, these contributions are generally much lower than those from seismic and fire events. Therefore, the assessment of the environmental impact from external events provided here focuses on seismic and fire events. This is consistent with the results obtained from the IPEEEs and the perspectives articulated in NUREG-1742.

E.3.2.1 Airborne Pathway Impacts

The assessment in this section is based upon a comparison of the risks and environmental impacts from severe accidents initiated by external events to those initiated by internal events, based on the aforementioned information sources.

Level 1 Comparison (CDF)

From the IPEEE the following insights can be drawn:

(1) For a majority of plants, fire and/or seismic events are important contributors to risk.

(2) The contributions to CDFs from fire events are comparable to the contribution to CDFs from internal events. The IPEEE CDF values for fire-initiated events are shown in Tables E-4 and E-5 along with the IPE internal event CDFs. For the plants listed in Tables E-4, the PWR fire CDF is about half the internal event CDF. For the BWR plants in Table E-5, the fire CDF is roughly 50 percent higher than the internal events CDF. Section 3.3.1.1 of NUREG-1742 (NRC 2003) provides a comparison of fire and internal events for the entire fleet of plants, and similarly concludes that BWR results are comparable, while PWR results are slightly lower for fire CDF.

However, the IPEEE fire event CDFs are much lower than the internal event CDFs from the original EISs (basis for the 1996 GEIS). The mean value of the PWR fire event CDFs in Table E-4 is one-third of the PWR internal event CDF from the EISs (see Table E-1), and the mean value of the BWR fire event CDFs in Table E-5 is less than half the BWR internal event CDF from the original EISs (see Table E-2).

(3) The contributions to CDF from seismic events are comparable to the contribution from internal events. For plants listed in Tables E-1 and E-2 that reported seismic CDFs as part of their IPEEE submittals, these CDFs are contained in Tables E-4 and E-5. Although sparse, these values suggest seismic CDFs are lower than or comparable to internal event CDFs. Section 2.6.1 of NUREG-1742 considers all reporting plants, and states that the largest group of reported seismic CDFs were in the range of 1×10^{-5} to 1×10^{-4} (same order of magnitude as the basis for the 1996 GEIS), with the next largest

Table E-4. PWR Internal, Fire, and Seismic Event CDF Comparison (Full Power)[(a)]

Plant	IPE Internal Events CDF	IPEEE Fire CDF	IPEEE Seismic CDF (EPRI/Other/Update)	IPEEE Seismic CDF (LLNL)
Beaver Valley 2	1.9×10^{-4}/yr	1.1×10^{-5}/yr	1×10^{-5}/yr	2.3×10^{-5}/yr
Braidwood 1, 2	2.7×10^{-5}/yr	3.9×10^{-6}/yr		
		3.8×10^{-6}/yr		
Byron 1, 2	3.1×10^{-5}/yr	4.2×10^{-6}/yr		
		5.3×10^{-6}/yr		
Callaway 1	5.9×10^{-5}/yr	8.9×10^{-6}/yr		
Catawba 1, 2	5.8×10^{-5}/yr	4.6×10^{-6}/yr	1.6×10^{-5}/yr	
Comanche Peak 1, 2	5.7×10^{-5}/yr	2.1×10^{-5}/yr		
Shearon Harris 1	7.0×10^{-5}/yr	1.3×10^{-5}/yr		
Indian Point 2, 3	3.1×10^{-5}/yr	1.8×10^{-5}/yr	1.3×10^{-5}/yr	1.5×10^{-5}/yr
	4.4×10^{-5}/yr	5.6×10^{-5}/yr	5.9×10^{-5}/yr	4.4×10^{-5}/yr
Millstone 3	5.6×10^{-5}/yr	4.8×10^{-6}/yr	9.1×10^{-6}/yr	
Palo Verde 1, 2, 3	9.0×10^{-5}/yr	8.7×10^{-5}/yr		
San Onofre 2, 3	3.0×10^{-5}/yr	1.6×10^{-5}/yr	1.7×10^{-5}/yr	
Seabrook 1	6.1×10^{-5}/yr[(b)]	1.2×10^{-5}/yr	1.2×10^{-5}/yr	1.3×10^{-4}/yr
South Texas 1, 2	4.3×10^{-5}/yr	5.1×10^{-7}/yr	1.9×10^{-7}/yr	2.2×10^{-5}/yr
St. Lucie 2	2.6×10^{-5}/yr	1.9×10^{-4}/yr		
Summer 1	2.0×10^{-4}/yr	8.5×10^{-5}/yr		
Vogtle 1, 2	4.9×10^{-5}/yr	1.0×10^{-5}/yr		
Waterford 3	1.8×10^{-5}/yr	7.0×10^{-6}/yr		
Wolf Creek 1	4.2×10^{-5}/yr	7.6×10^{-6}/yr		
Mean Value	5.9×10^{-5}/yr	2.8×10^{-5}/yr	1.5×10^{-5}/yr	4.3×10^{-5}/yr

(a) Source: NRC 2003, unless otherwise stated.
(b) Obtained from the licensee's IPEEE submittal.

group being 1×10^{-6} to 1×10^{-5} (one order of magnitude lower than the basis for the 1996 GEIS).

(4) As a result of the IPEEE program, most licensees have made improvements to plant hardware, procedures, or training programs. Although not generally quantified as part of the IPEEE, those improvements are, in many cases, considered to have lowered the reported risk estimates.

Table E-6 compares CDFs from NUREG-1150 (NRC 1990b) and NUREG/CR-5305 (NRC 1992) for internal, fire, and seismic events with the internal events from the original EISs (which

Table E-5. BWR Internal, Fire, and Seismic Event CDF Comparison (Full Power)[(a)]

Plant	IPE Internal Events CDF	IPEEE Fire CDF	IPEEE Seismic CDF (EPRI/Other/Update)	IPEEE Seismic CDF (LLNL)
Clinton 1	2.7×10^{-5}/yr	3.6×10^{-6}/yr		
Fermi 2	5.7×10^{-6}/yr	2.2×10^{-5}/yr		
Grand Gulf 1	1.7×10^{-5}/yr	8.9×10^{-6}/yr		
Hope Creek	4.6×10^{-5}/yr	8.1×10^{-5}/yr	1.1×10^{-6}/yr	3.6×10^{-6}/yr
Limerick 1, 2	4.3×10^{-6}/yr	NA[(b)]		
Nine Mile Point 2	3.1×10^{-5}/yr	1.4×10^{-6}/yr	2.5×10^{-7}/yr	1.2×10^{-6}/yr
Perry 1	1.3×10^{-5}/yr	3.3×10^{-5}/yr		
River Bend	1.6×10^{-5}/yr	2.3×10^{-5}/yr		
Susquehanna 1, 2	5.6×10^{-7}/yr[(c)]	3.6×10^{-8}/yr		
WNP-2[(d)]	1.8×10^{-5}/yr	5.5×10^{-5}/yr	2.1×10^{-5}/yr	
Mean Value	1.5×10^{-5}/yr	2.3×10^{-5}/yr	7.5×10^{-6}/yr	2.4×10^{-6}/yr

(a) Source: NRC 2003, unless otherwise stated.
(b) NA = not available.
(c) Revised 1998 IPE; obtained from NUREG-1437, Supp. 35, Appendix G.
(d) WNP-2 = Washington Nuclear Project 2 (i.e., Columbia).

Table E-6. NUREG-1150 and NUREG/CR-5305 Fire and Seismic CDFs

Plant	Internal Events (mean value)	Fire Events (mean value)	Seismic Events (mean value)[(a)]	1996 GEIS Basis Internal Events (mean value)
Surry (NUREG-1150)	4×10^{-5}/yr	1.1×10^{-5}/yr	1.9×10^{-4}/yr	8.4×10^{-5}/yr[(b)]
Peach Bottom (NUREG-1150)	4.4×10^{-6}/yr	2×10^{-5}/yr	7.5×10^{-5}/yr	5.4×10^{-5}/yr[(c)]
LaSalle (NUREG/CR-5305)	4×10^{-5}/yr	5.5×10^{-5}/yr	8×10^{-7}/yr	5.4×10^{-5}/yr[(c)]

(a) Based on the LLNL seismic hazard distribution results.
(b) This value is the mean of the CDFs of all PWRs listed in Table 5.1 of the 1996 GEIS.
(c) This value is the mean of the CDFs of all BWRs listed in Table 5.1 of the 1996 GEIS.

formed the basis for the 1996 GEIS). As can be seen in this table, the NUREG-1150 and NUREG/CR-5305 fire and seismic CDFs are comparable to those supporting the 1996 GEIS, with a number of both relatively lower and higher comparisons.[j]

In support of early site permits for new reactors, the NRC staff reviewed updates to seismic source and ground motion models provided by applicants. The updates to seismic data and models could result in estimated seismic hazard levels at some current central and eastern U.S. operating sites that would be higher than seismic hazard values used in design and previous evaluations (such as the IPEEEs). Due to its relevance for other licensing actions, the issue is being pursued as part of the Generic Issues Program, as Generic Issue 199 (GI-199). A preliminary assessment performed for the affected plants as part of GI-199 indicates that the average increase in seismic CDF relative to the IPEEE-era estimates would be about 1×10^{-5} per year. However, this assessment also indicates that on average, the updated seismic CDF remains slightly (approximately 30 percent) less than the internal events CDF.

Level 3 Comparison (Offsite Consequences)

To obtain quantitative information on the airborne pathway environmental impacts of severe accidents caused by external events, IPEEE, NUREG-1150, and NUREG/CR-5305 results can be used to compare against the internal event airborne pathway impacts contained in the 1996 GEIS. The following discussion summarizes the airborne pathway environmental impact information available.

The IPEEE provided external event environmental impact information (i.e., early fatalities, latent fatalities, and population dose) for Catawba and McGuire. This information showed the impacts of external events to be much less (i.e., one to two orders of magnitude) than those estimated for internally initiated events at full power in the 1996 GEIS for Catawba and McGuire (see Table E-7). Recall that while this is a comparison of mean values versus 95 percent upper confidence bound (UCB) values, the 95 percent UCB values are the ones used for the basis of the 1996 GEIS. Thus, this comparison shows that more realistic estimates are significantly lower than the conservative estimates used in the GEIS.

(j) The NUREG-1150 values represented best-estimate values at the time they were completed. For Surry, the Lawrence Livermore National Laboratory (LLNL) NUREG-1150 curve is uniformly higher than other seismic hazard estimates (e.g., the Electric Power Research Institute [EPRI] and LLNL curves used for the IPEEEs, recent United States Geological Survey curves). For Peach Bottom, the EPRI NUREG-1150 curve is uniformly lower.

Table E-7. Catawba and McGuire Results for Internal and External Events

Impact	Catawba External Events	Catawba Internal Events	Catawba 1996 GEIS Internal Events (95 percent UCB)	McGuire External Events	McGuire Internal Events	McGuire 1996 GEIS Internal Events (95 percent UCB)
Total person-rem per year	43.6	15.6	1,880	10.7	4.6	1,806
Total early fatality risk	7.8×10^{-6}/yr	5.9×10^{-6}/yr	1.7×10^{-2}/yr	2.2×10^{-6}/yr	8.2×10^{-7}/yr	1.0×10^{-2}/yr
Total latent fatality risk	2.7×10^{-3}/yr	9.4×10^{-4}/yr	1.4/yr[(a)]	7.4×10^{-4}/yr	3.2×10^{-4}/yr	1.4/yr[(a)]

(a) These values include the factor of 10 adjustment made in the 1996 GEIS (see Section 5.3.3.2.3 of the 1996 GEIS).

Fire Events

NUREG-1150 provides quantitative information on the airborne pathway environmental impact from fires for Surry and Peach Bottom. This information is shown in Tables E-8 and E-9 along with the full power, internal event environmental impact information from NUREG-1150 and the 1996 GEIS. NUREG/CR-5305 provides similar information for LaSalle, as presented in Table E-10. Tables E-8 through E-10 present 95th percentile results for all values. As can be seen from these tables, even 95th percentile values from NUREG-1150 and NUREG/CR-5305 are significantly lower (at least by 1 order of magnitude) than the conservative values used in the 1996 GEIS.

Seismic Events

Table E-11 presents mean results from the second-tier NUREG-1150 study documentation (NUREG/CR-4551; NRC 1990a) for impacts due to seismic initiators at Surry and Peach Bottom. As can be seen from this table, the mean results from the NUREG-1150 study are, in most cases, significantly smaller than the 95th percentile estimates used in the 1996 GEIS.

E.3.2.2 Other Pathway Impacts

With respect to the other pathways (open bodies of water and groundwater), the IPEEE, NUREG-1150, and NUREG/CR-5305 analysis did not address their impacts on human health. The 1996 GEIS estimated these impacts for reactor accidents from full power (internal events only) using the results from site-specific information on surface water and groundwater areas, volumes, flow-rates, and geology to assess contamination of water by comparing the site-specific information to that used in NUREG-0440 (NRC 1978), which assessed the contamination of surface water and groundwater from reactor accidents.

Table E-8. Impacts of Accidents Caused by Fire Events (Surry)

Impact	NUREG-1150 Fire Events (95th percentile)	NUREG-1150 Internal Events (95th percentile)	1996 GEIS Internal Events (95th percentile)
Individual risk			
- EF[(a)] (1 mi)	~1.5×10^{-10}/yr	~5×10^{-8}/yr	Not available
- LF[(b)] (10 mi)	~1.5×10^{-10}/yr	~1×10^{-8}/yr	Not available
Total person-rem per year (entire region)	~2	~150	1,200
Total early fatality risk	~1×10^{-8}/yr	~4×10^{-6}/yr	1.6×10^{-2}/yr
Total latent fatality risk	~6×10^{-4}/yr	~3×10^{-2}/yr	0.9/yr

(a) EF = early fatality risk. The individual early fatality risk within one mile (1.6 km) is the frequency (per year) that a person living within one mile (1.6 km) of the site boundary will die within a year due to the accident. The entire population within one mile is considered to obtain an average value.

(b) LF = latent fatality risk. The individual latent cancer fatality risk within 10 miles (16 km) is the frequency (per year) that a person living within 10 miles (16 km) of the plant will die many years later from cancer due to radiation exposure received from the accident. The entire population within 10 miles (16 km) is considered to obtain an average value.

Table E-9. Impacts of Accidents Caused by Fire Events (Peach Bottom)

Impact	NUREG-1150 Fire Events (95th percentile)	NUREG-1150 Internal Events (95th percentile)	1996 GEIS Internal Events (95th percentile)
Individual risk			
- EF[(a)] (1 mi)	~1.5×10^{-9}/yr	~2.5×10^{-10}/yr	Not available
- LF[(b)] (10 mi)	~1×10^{-8}/yr	~1.5×10^{-9}/yr	Not available
Total person-rem per year (entire region)	~700	~100	2,950
Total early fatality risk	~1.5×10^{-6}/yr	~1×10^{-7}/yr	4.2×10^{-3}/yr
Total latent fatality risk	~0.15/yr	~2×10^{-2}/yr	2.0/yr

(a) EF = early fatality risk. The individual early fatality risk within one mile (1.6 km) is the frequency (per year) that a person living within one mile (1.6 km) of the site boundary will die within a year due to the accident. The entire population within one mile is considered to obtain an average value.

(b) LF = latent fatality risk. The individual latent cancer fatality risk within 10 miles (16 km) is the frequency (per year) that a person living within 10 miles (16 km) of the plant will die many years later from cancer due to radiation exposure received from the accident. The entire population within 10 miles (16 km) is considered to obtain an average value.

Table E-10. Impacts of Accidents Caused by Fire Events (LaSalle)

Impact	NUREG/CR-5305 Fire Events (95th percentile)	NUREG/CR-5305 Internal Events (95th percentile)	1996 GEIS Internal Events (95th percentile)
Individual risk			
- EF[(a)] (1 mi)	~1.1×10^{-10}/yr	~1.5×10^{-10}/yr	Not available
- LF[(b)] (10 mi)	~1.0×10^{-8}/yr	~1.3×10^{-8}/yr	Not available
Total person-rem per year	~1,920	~2,600	2,898
Total early fatality risk	~9×10^{-9}/yr	~1.2×10^{-8}/yr	3.6×10^{-3}/yr
Total latent fatality risk	~0.3/yr	~0.4/yr	2.0/yr

(a) EF = early fatality risk. The individual early fatality risk within one mile (1.6 km) is the frequency (per year) that a person living within one mile (1.6 km) of the site boundary will die within a year due to the accident. The entire population within one mile is considered to obtain an average value.
(b) LF = latent fatality risk. The individual latent cancer fatality risk within 10 miles is the frequency (per year) that a person living within 10 miles (16 km) of the plant will die many years later from cancer due to radiation exposure received from the accident. The entire population within 10 miles (16 km) is considered to obtain an average value.

Table E-11. Impacts of Accidents Caused by Seismic Events

Impact	Surry		Peach Bottom	
	NUREG/CR-4551 Surry[(a)] LLNL (*EPRI*) Hazard Curve	1996 GEIS (95th percentile)	NUREG/CR-4551 Peach Bottom[(a)] LLNL (*EPRI*) Hazard Curve	1996 GEIS (95th percentile)
Individual risk				
- EF[(b)] (1 mi)	1.8×10^{-7}/yr (*1.8×10^{-8}/yr*)		1.6×10^{-6}/yr (*5.3×10^{-8}/yr*)	
- LF[(c)] (10 mi)	3.1×10^{-8}/yr (*3.8×10^{-9}/yr*)		3.4×10^{-7}/yr (*1.1×10^{-8}/yr*)	
Total person-rem per year	45 (*6.7*)	1,200	460 (*17*)	2,950
Total early fatality risk	9.3×10^{-5}/yr (*1.4×10^{-5}/yr*)	1.6×10^{-2}/yr	3.0×10^{-3}/yr (*8.8×10^{-5}/yr*)	4.2×10^{-3}/yr
Total latent fatality risk	3.9×10^{-2}/yr (*5.6×10^{-3}/yr*)	0.9/yr	2.5×10^{-1}/yr (*9.9×10^{-3}/yr*)	2.0/yr

(a) Mean values.
(b) EF = early fatality risk. The individual early fatality risk within one mile (1.6 km) is the frequency (per year) that a person living within one mile (1.6 km) of the site boundary will die within a year due to the accident. The entire population within one mile is considered to obtain an average value.
(c) LF = latent fatality risk. The individual latent cancer fatality risk within 10 miles (16 km) is the frequency (per year) that a person living within 10 miles (16 km) of the plant will die many years later from cancer due to radiation exposure received from the accident. The entire population within 10 miles (16 km) is considered to obtain an average value.

With the airborne pathway impacts from external events much less than the internal event airborne pathway impacts in the 1996 GEIS, it is reasonable to conclude that the impact of accidents caused by external events on surface water and groundwater contamination will also be much less than the impacts contained in the 1996 GEIS. Due to the longer time before the population is exposed and the effects of interdiction of contaminated food, only latent fatalities are expected to result from these pathways. Therefore, the environmental impacts of surface and groundwater contamination caused by accidents initiated by external events are bounded by the impacts stated in the 1996 GEIS. This same conclusion can also be drawn with respect to the economic impacts that are caused by the environmental contamination.

E.3.2.3 Conclusion

In summary, it is concluded that the CDFs from severe accidents initiated by external events, as quantified in NUREG-1150 (NRC 1990b) and the other sources cited above, are comparable to those from accidents initiated by internal events but lower than the CDFs that formed the basis for the 1996 GEIS. The environmental impacts from externally initiated events are generally significantly lower (one or more orders of magnitude) than those used in the 1996 GEIS.

E.3.3 Impact of New Source Term Information

The 1996 GEIS used information from 28 plant-specific EISs to project the environmental impact from all 118 plants analyzed (see Table 5.5 in the 1996 GEIS). The 28 sites chosen were those for which the impacts from severe accidents were analyzed in their plant-specific EISs. As stated in Section 5.3.3.1 of the 1996 GEIS, the source terms (i.e., the magnitude, timing, and characteristics of the radioactive material released to the environment) used in the EIS analyses for the 28 sites (and subsequently used to estimate the environmental impacts from all plants) were generally based on those documented in NUREG-0773 (NRC 1982). The NUREG-0773 source terms represented an update (re-baseline) of the source terms used in WASH-1400 (NRC 1975). The source terms in NUREG-0773 were developed for PWRs and BWRs and are shown in Tables 13 and 14A of that document. NUREG-0773 states that the provided source terms are based on models that have “known deficiencies which would tend to give overestimates of the magnitude of the releases.”

Since completion of NUREG-0773, additional information on source terms has been developed through experimental and analytical programs. The purpose of this section is to assess the impact of new source term information on the environmental impacts described in the 1996 GEIS. The new source term information assessed is that used in NUREG-1150 (NRC 1990b) as updated and simplified in NUREG/CR-6295 (NRC 1997b).

E.3.3.1 Airborne Pathway Impact

Tables E-12 and E-13 present a comparison of the results for large release sequences from NUREG-0773 (NRC 1982) and NUREG/CR-6295 (NRC 1997b). These sequences typically dominate the total risk from all severe accidents. In this case, large release sequences have been selected from the full set of sequences in each study based on a total iodine release fraction of 10 percent or higher. These tables present release frequencies, timings, and release fractions for iodine and cesium, which are the elements that contribute the most to early (iodine) and latent (cesium) fatalities. Only limited comparisons between the studies are possible due to differences in the sequences analyzed in each study and their associated release modes. Nevertheless the following observations can be made:

- The sum of the release frequencies from NUREG/CR-6295 is lower than those from NUREG-0773 for all containment types, with the exception of the NUREG/CR-6295 LaSalle sequences. However, the higher release frequency for LaSalle is offset by lower release fractions at LaSalle.

Table E-12. NUREG-0773 and NUREG/CR-6295 Large Source Terms (PWRs)

Source		Sequence	Frequency	Release Time (hr)	Release Duration (hr)	Post Core Uncovery Delta (hr)[a]	Iodine Release Fraction	Cesium Release Fraction
NUREG-0773	Surry	Event V (Bypass)	4×10^{-6}/yr	1	1	0.5	0.64	0.82
		TMLB'-δ (CF during CD)	3×10^{-6}/yr	2.5	0.5	1	0.31	0.39
		PWR-3 (CR during CD)	3×10^{-6}/yr	5	1.5	2	0.2	0.2
		Sum	1×10^{-5}/yr					
NUREG/CR-6295	Surry	RSUR1[b] (CF at VB)	2.9×10^{-7}/yr	6	2	1	0.35	0.31
		RSUR4[b] (Bypass)	1.6×10^{-6}/yr	1	2.5	0.7	0.12	0.12
		Sum	1.9×10^{-6}/yr					
	Sequoyah	RSEQ1[b] (CF during CD)	2.8×10^{-7}/yr	5.5	2	0.5	0.59	0.62
		RSEQ2[b] (CF at VB)	3.6×10^{-6}/yr	6	2	1	0.18	0.19
		RSEQ5[b] (Bypass)	3.1×10^{-6}/yr	1	2.5	0.7	0.12	0.12
		Sum	7×10^{-6}/yr					

(a) For NUREG-0773, this represents the interval of time between the decision to take protective measures and the start of the release; for NUREG/CR-6295, this represents the time between core uncovery and the start of the release.
(b) These source terms have multiple plumes, which have been summed here for ease of comparison.
Bypass = fission product released from the reactor bypass the containment.
CF = containment failure.
CD = core damage.
VB = reactor vessel branch.

Table E-13. NUREG-0773 and NUREG/CR-6295 Large Source Terms (BWRs)

Source		Sequence	Frequency	Release Time (hr)	Release Duration (hr)[(a)]	Post Core Uncovery Delta (hr)[(a)]	Iodine Release Fraction	Cesium Release Fraction
NUREG-0773	Peach Bottom	AEα' (CF before VB)	2×10^{-9}/yr	0.8	0.5	0.5	0.3	0.6
		AEα (CF before VB, scrub)	1×10^{-9}/yr	0.8	0.5	0.5	0.2	0.4
		TCγ' (CF before CD)	2×10^{-6}/yr	1.5	2.0	1.0	0.5	0.6
		TW γ' (CF before CD)	3×10^{-6}/yr	50	2.0	40	0.1	0.3
		Sum	5×10^{-6}/yr					
NUREG/CR-6295	Peach Bottom	RPB1[(b)] (CF at VB)	1.2×10^{-6}/yr	11.5	4.3	3.5	0.11	0.1
		RPB2[(b)] (CF at VB)	1.0×10^{-6}/yr	7.3	4.3	2.5	0.11	0.1
		RPB6[(b)] (CF at VB)	3×10^{-8}/yr	11.5	4.3	3.5	0.44	0.4
		Sum	2.2×10^{-6}/yr					
	LaSalle	RLAS1[(b)] (CF before VB)	6.3×10^{-6}/yr	58	13.5	4.8	0.16	0.17
		RLAS2[(b)] (CF at VB)	6.2×10^{-6}/yr	3.8	7.3	2.5	0.15	0.03
		RLAS3[(b)] (CF at VB)	1.2×10^{-6}/yr	16.9	6.3	5.8	0.11	0.07
		RLAS4[(b)] (CF before VB)	2.4×10^{-6}/yr	23.7	1.8	0.5	0.18	0.12
		Sum	1.6×10^{-5}/yr					
	Grand Gulf	RGG1[(b)] (CF at VB)	8.4×10^{-7}/yr	3.6	4	2.6	0.23	0.11
		RGG3[(b)] (Late CF)	1.2×10^{-6}/yr	14	4	13	0.15	0.01
		Sum	2×10^{-6}/yr					

(a) For NUREG-0773, this represents the interval of time between the decision to take protective measures and the start of the release; for NUREG/CR-6295, this represents the time between when the water level reaches 2 feet above the bottom of the active fuel and the start of the release.
(b) These source terms have multiple plumes, which have been summed here for ease of comparison.
CF = containment failure.
CD = core damage.
VB = reactor vessel branch.

- Where direct comparisons can be made (i.e., for bypass sequences in PWRs and containment failures before vessel breach in BWRs) the release fractions from NUREG/CR-6295 are significantly lower than those from NUREG-0773.

- For several sequences in NUREG/CR-6295, the release fractions appear to be comparable to or slightly greater than those from NUREG-0773 (e.g., PWR sequence RSEQ1 and BWR sequence RPB6 which have a release magnitude comparable to the largest PWR release and BWR release from NUREG-0773, respectively. However, the release frequencies reported in NUREG/CR-6295 for these sequences are one to two orders of magnitude lower than those from NUREG-0773, resulting in a lower risk impact.

- The release times and the difference in time between core uncovery and release to the atmosphere are generally comparable between the two studies.

Based on the comparisons provided above, the expected impacts, i.e., the frequency-weighted consequences, from the airborne pathway using the updated source term information would be much lower than previously predicted.

E.3.3.2 Other Pathway Impacts

Since the comparison of the new source term information to that used in the 1996 GEIS environmental impact projection shows that the amount of release of radioactive material in a severe accident is estimated to be less than estimated in the 1996 GEIS, the environmental impacts from the other pathways (contamination of open bodies of water, groundwater contamination, and the resulting economic impacts from any pathway) will also be less than estimated in the 1996 GEIS.

E.3.3.3 Conclusion

More recent source term information indicates that the timing from dominant severe accident sequences, as quantified in NUREG/CR-6295 (NRC 1997b), is comparable to the analysis forming the basis of the 1996 GEIS. In most cases, the release frequencies and release fractions are significantly lower for the more recent estimate. Thus, the environmental impacts used as the basis for the 1996 GEIS (i.e., the frequency-weighted consequences) are higher than the impacts that would be estimated using the more recent source term information.

It is worth noting that a significant effort is ongoing to re-quantify realistic severe accident source terms under the State-of-the Art Reactor Consequence Analysis (SOARCA) Project. Preliminary results indicate that source term timing and magnitude may be significantly lower than quantified in previous studies (NRC 2008a). This information will be incorporated, as appropriate, in future revisions of this document.

E.3.4 Impact of Power Uprates

Power uprates are defined as the process of increasing the maximum power level at which a nuclear power plant may operate. Although power uprates have been approved by the NRC since 1977, the effects of power uprates since 1996 were not taken into account for the GEIS. Extended power uprates began to be approved in 1998. For BWRs, it became common for a power uprate to be between 10 and 20 percent, and for PWRs, up to 5 percent. The purpose of this section is to provide an assessment of the impacts of power uprates on severe accident scenarios and their environmental impacts.

The process of license amendments for power uprates requires licensees to evaluate the effects of the uprate on the safety of the plant. Design-basis accidents were analyzed to determine the change in possible dose, should an accident occur. Most commonly, loss of coolant accidents, control rod drop accidents and fuel handling accidents were assessed. Whole body and thyroid doses were determined for the exclusion area boundary, the outer edge of the low population zone, and the main control room. These values must meet 10 CFR Part 100 and 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 19 dose limits. The effects of power uprates on CDF and large early release frequency (LERF) are also assessed.

E.3.4.1 Airborne Pathway Impacts

Power uprates require using fuel with a higher percentage of uranium-235 or additional fresh fuel in order to derive more energy from the operation of the reactor. This results in a larger radionuclide inventory (particularly short-lived isotopes, assuming no change in burnup limits) in the core, than the same core at a lower power level. The larger radionuclide inventory represents a larger source term for accidents and can result in higher doses to offsite populations in the event of a severe accident. Typically, short-lived isotopes are the main contributor to early fatalities. As stated in NUREG-1449 (NRC 1993), short-lived isotopes make up 80 percent of the dose following early release.

LERF represents the frequency of sequences that result in early fatalities. Thus, the impact of a power uprate on early fatalities can be gauged by considering the impact of the uprate on the LERF metric. To this end, Table E-14 presents the change in LERF calculated by each licensee who has been granted a power uprate of greater than 10 percent. As can be seen, the increase in LERF ranges from a minimal impact to an increase of 30 percent (with a mean of 10.5 percent). This change is judged to be small to moderate.

Table E-14. Changes in LERF for Extended Power Uprates >10 Percent

Plant	Percent Increase in Power	Percent Increase in Internal Event LERF
Brunswick 1, 2	15	4.5
Clinton	20	5.5
Dresden 2, 3	17	10
Duane Arnold	15.3	16
Ginna	16.8	19
Hope Creek	15	30
Quad Cities 1, 2	17.8	4
Susquehanna 1, 2	13	<1
Vermont Yankee	20	5
Mean	16.4	10.5

E.3.4.2 Other Pathway Impacts

As discussed in previous sections, the change in impacts due to other pathways is viewed to be bounded by the change in the airborne pathway, consistent with the results obtained in the 1996 GEIS.

E.3.4.3 Conclusion

Power uprates would result in a small to (in some cases) moderate increase in the environmental impacts from a postulated accident. However, taken in combination with the other information presented in this appendix, the increases would be bounded by the 95 percent UCB values in Tables 5.10 and 5.11 of the 1996 GEIS.

E.3.5 Impact of Higher Fuel Burnup

There has been continued movement toward higher fuel burnup, to allow for more efficient utilization of the fuel and longer operating cycles. An environmental assessment (EA) was published by the NRC in 1988 on the effects of increased peak burnup (to 60 GWd/MT, 5 percent by weight uranium-235). NUREG/CR-5009 (NRC 1988) is the basis for the EA. NUREG/CR-6703 (NRC 2001a) is a more current analysis using updated designs and data, and peak burnup to 75 GWd/MT.

The purpose of this section is to include the updated information from NUREG/CR-6703 into the GEIS to account for the effect of current and possible future increased fuel burnup on postulated accidents. Future peak burnups being considered are 62 GWd/MT for PWRs and 70 GWd/MT for BWRs.

E.3.5.1 Airborne Pathway Impacts

The environmental impacts of accidents where high burnup fuel is being used (assuming no change in plant power level) are due to the effects of an increased inventory of long-lived fission products. Long-lived fission products contribute primarily to latent health effects, and thus latent fatalities are used here as a measure of the impact of higher burnup fuel. Since latent fatalities are directly scalable to dose, the assessment is based upon the increase in population dose due to the use of high burnup fuel.

NUREG/CR-6703 (NRC 2001a) analyzed design-basis accidents from full power for PWR and BWR reactors at different levels of fuel burnup. A PWR steam generator tube rupture and a BWR main steam line break were analyzed. Burnup was analyzed to 75 GWd/MT, at which point, fuel with more than 5 percent by weight uranium-235 would be required. As described on page 25 of that document, the models used do not account for natural processes and engineered safety features, so "more attention should be paid to trends in doses than to absolute values."

Table E-15 shows doses at the exclusion area boundary (EAB) and the total population dose stated in NUREG/CR-6703. The EAB dose includes contributions from inhalation, and external dose. The total population dose also includes contributions from contaminated foods as well. The increase in population dose is moderate (~38 percent) from 42 to 75 GWd/MT for PWRs. For BWRs, the net increase in population dose is small (~8 percent). Although the analysis in NUREG/CR-6703 is for design-basis accidents, the percentage increase in impacts would be generally similar for severe accidents.

Table E-15. LOCA Consequences as a Function of Fuel Burnup

Reactor Type	Peak-Rod Burnup (GWd/MT)	Individual Dose at 0.8 km[(a)] (rem)[(b)]	Mean Total Population Dose (person-rem)[(b)]
PWR	42	10	940,000
	50	10	1,100,000
	60	10	1,200,000
	62	10	1,200,000
	65	11	1,200,000
	70	11	1,300,000
	75	11	1,300,000
BWR	60	10	1,300,000
	62	10	1,300,000
	65	10	1,300,000
	70	11	1,400,000
	75	11	1,400,000

(a) 0.8 km = 0.5 mi.
(b) Note that these doses are on a per event basis, not a frequency (per year) basis.

E.3.5.2 Other Pathway Impacts

As discussed in previous sections, the change in impacts due to other pathways is viewed to be bounded by the change in the airborne pathway, consistent with the results obtained in the 1996 GEIS.

E.3.5.3 Conclusion

Increased peak fuel burnup from 42 to 75 GWd/MT for PWRs, and 60 to 75 GWd/MT for BWRs, results in small to moderate increases (up to 38 percent) in the environmental impacts in the event of a severe accident. However, taken in combination with the other information presented in this appendix, the increases would be bounded by the 95 percent UCB values in Tables 5.10 and 5.11 of the 1996 GEIS.

E.3.6 Impact from Accidents at Low Power and Shutdown Conditions

The 1996 GEIS did not include an assessment of the environmental impacts of accidents initiated at low power or shutdown conditions. These conditions include power levels less than 5 percent, shutdown (with or without maintenance or plant modifications under way), and fuel handling. The safety concern under these conditions is that plant configurations may be established where not all plant safety systems and features would be operable (e.g., containment integrity may not be required), and activities (e.g., plant modification) could be under way that could not be done while at full power. Accordingly, accidents initiated at such conditions may have different initiators, progress differently, and have different consequences than those initiated at full power conditions. In addition, operating experience has shown that events affecting fuel cooling do occur during shutdown operation. Accordingly, the industry implemented a number of voluntary measures in response to NRC generic letters and bulletins, and in 1991 developed guidelines for the assessment of shutdown management and implementation of safety improvements (NUMARC 1991). As discussed in SECY-97-168 (NRC 1997c), these voluntary industry initiatives resulted in improved safety.

The purpose of this section is to provide an assessment of the risk from postulated severe accidents at low power and shutdown conditions relative to the risk from postulated severe accidents at full power conditions, including a comparison against the findings in the 1996 GEIS.

The conditions assessed are:

- Plant operation at power levels between 0 and 5 percent;
- Shutdown with containment open; and
- Fuel handling inside the containment structure.

Several sources of information are available to support this assessment. These include studies that have been done assessing actual events and the risk from accidents at low power and shutdown conditions. These studies are: (1) NUREG-1449 (NRC 1993); (2) NUREG/CR-6143 (NRC 1995b); and (3) NUREG/CR-6144 (NRC 1995a). In addition, in 1997, the NRC staff recommended a proposed rule be considered to address shutdown conditions. Although the Commission did not approve going forward with the proposed rule (see SRM-97-168, NRC 1997d), the technical basis for the proposed rule provides additional useful information.

E.3.6.1 Airborne Pathway Impacts

NUREG-1449 (NRC 1993) presents an analysis of actual events that have occurred at low power and shutdown conditions. This analysis includes an estimate of the conditional core damage frequency associated with each event and an overall assessment of the range of total core damage frequencies (mean value) that could result from events at low power and shutdown conditions. This range was from 10^{-5}/yr to 10^{-4}/yr.

NUREG/CR-6143 (NRC 1995b) and NUREG/CR-6144 (NRC 1995a) provide low power and shutdown risk assessments for two plants (Grand Gulf and Surry). For Grand Gulf, the mean core damage frequency stated in NUREG/CR-6143 is approximately 2×10^{-6}/yr and for Surry (NUREG/CR-6144) it is 4×10^{-6}/yr. However, such core damage frequencies need to be considered with respect to their consequences. Due to the decay time associated with low power and shutdown conditions (i.e., decay of short-lived isotopes and lower decay heat) and, in most cases, longer times available to take mitigative action, the offsite consequences would be less than for accidents from full power. However, in certain plant operating states, the containment in those states may be open. Thus, a higher conditional probability for containment bypass might exist.

NUREG/CR-6143 and NUREG/CR-6144 also provide estimates of the offsite airborne pathway consequences on human health from accidents (internal events only) at low power and shutdown conditions. Tables E-16 and E-17 list these estimates for Grand Gulf and Surry, respectively. Also shown for each plant are the airborne pathway offsite consequence results for accidents from full power from NUREG-1150 (NRC 1990b) (for internal events) and from the 1996 GEIS. As can be seen, the airborne impacts (airborne pathway risk and probability-weighted consequences) from accidents at low power and shutdown are comparable to those from full power, as quantified in these studies. Although the impacts for low power and shutdown conditions are somewhat greater (by about a factor of 2 to 5) for certain metrics, these differences are small in an absolute sense. Moreover, the airborne impacts of accidents from low power and shutdown are significantly less than those stated in the 1996 GEIS (by more than an order of magnitude). Thus, even though the 1996 GEIS estimates regarding the airborne pathway environmental impact are for internal events at full power only, their conservatism causes them to bound the impacts from accidents at low power and shutdown.

E.3.6.2 Other Pathway Impacts

For the impacts from surface water and groundwater contamination from accidents at low power and shutdown, the estimates for accidents from full power (internal events only) in the 1996 GEIS can be used for comparison. In the 1996 GEIS, for the surface water pathways, it was estimated that the impacts from the drinking water pathway would be a small fraction of those for the airborne pathway. The risk associated with the aquatic food pathway was found to be

Table E-16. Airborne Impacts of Low Power and Shutdown Accidents (Grand Gulf)

Impact	Low Power/Shutdown Accidents NUREG/CR-6143 (95th percentile values)	Full Power Accidents Internal Events NUREG-1150 (95th percentile values)	Full Power Accidents Internal Events 1996 GEIS (95th percentile values)
Individual risk			
EF[(a)] (1 mi)	~3×10^{-10}/yr	~1.5×10^{-10}/yr	
LF[(b)] (10 mi)	~5×10^{-9}/yr	~1×10^{-9}/yr	
Total person-rem per year (entire region)	~28	~15	1,441
Total early fatality risk	~4×10^{-8}/yr	~2.5×10^{-8}/yr	2.8×10^{-3}/yr
Total latent fatality risk	~1×10^{-2}/yr	~2.5×10^{-3}/yr	1.0/yr
CDF	5.6×10^{-6}/yr	1.2×0^{-5}/yr	2.4×10^{-5}/yr[(c)]

(a) EF = early fatality risk. The individual early fatality risk within one mile (1.6 km) is the frequency (per year) that a person living within one mile (1.6 km) of the site boundary will die within a year due to the accident. The entire population within one mile is considered to obtain an average value.
(b) LF = latent fatality risk. The individual latent cancer fatality risk within 10 miles (16 km) is the frequency (per year) that a person living within 10 miles (16 km) of the plant will die many years later from cancer due to radiation exposure received from the accident. The entire population within 10 miles (16 km) is considered to obtain an average value.
(c) This is the CDF from the Grand Gulf original EIS.

Table E-17. Airborne Impacts of Low Power and Shutdown Accidents (Surry)

Impact	Low Power/Shutdown Accidents (NUREG/CR-6144) (95th percentile values)	Full Power Accidents Internal Events NUREG-1150 (95th percentile values)	Full Power Accidents Internal Events 1996 GEIS (95th percentile values)
Individual risk			
EF[(a)] (1 mi)	~7×10^{-9}/yr	~4×10^{-8}/yr	
LF[(b)] (10 mi)	~7×10^{-9}/yr	~1×10^{-8}/yr	
Total person-rem per year (entire region)	~1.3	~150	1,200
Total early fatality risk	~2×10^{-7}/yr	~4×10^{-6}/yr	1.6×10^{-2}/yr
Total latent fatality risk	~5×10^{-2}/yr	~2.5×10^{-2}/yr	0.9/yr
CDF	1.9×10^{-5}/yr	1.3×10^{-4}/yr	

(a) EF = early fatality risk. The individual early fatality risk within one mile (1.6 km) is the frequency (per year) that a person living within one mile (1.6 km) of the site boundary will die within a year due to the accident. The entire population within one mile is considered to obtain an average value.
(b) LF = latent fatality risk. The individual latent cancer fatality risk within 10 miles (16 km) is the frequency (per year) that a person living within 10 miles (16 km) of the plant will die many years later from cancer due to radiation exposure received from the accident. The entire population within 10 miles (16 km) is considered to obtain an average value.

also relatively small compared to the risks associated with the airborne pathway for most sites and essentially the same as the atmospheric pathway for the few sites with large annual aquatic food harvests. With the airborne impacts from accidents at low power and shutdown in NUREG/CR-6143, -6144, and NUREG-1150 estimated to be considerably less than the impacts from accidents at full power in the 1996 GEIS, the surface water pathway impacts should likewise be less, and thus, the risks portrayed in the 1996 GEIS should be bounding.

Section 5.3.3.4 of the 1996 GEIS concluded that the contribution of risk from the groundwater pathway for at-power accidents "generally contributes only a small fraction of that risk attributable to the atmospheric pathway but in a few cases may contribute a comparable risk." Groundwater contamination due to basemat melt-through would be less likely than for accidents at full power, due to the lower decay heat associated with low power and shutdown events. Thus, the risks portrayed in the 1996 GEIS are considered to be bounding.

With respect to the economic impacts regardless of contamination pathway, the lower estimated person-rem/yr from accidents at low power and shutdown should also result in lower economic impacts than from accidents at full power.

E.3.6.3 Conclusion

In summary, it is concluded that the environmental impacts from accidents at low power and shutdown conditions are generally comparable to those from accidents at full power when comparing the NUREG/CR-6143 (NRC 1995b) and NUREG/CR-6144 (NRC 1995a) values to NUREG-1150 (NRC 1990b) values. Although the impacts for low power and shutdown conditions could be somewhat greater than for full power (for certain metrics), the 1996 GEIS estimates of the environmental impact of severe accidents bound the potential impacts from accidents at low power and shutdown with margin. Finally, as cited above and discussed in SECY-97-168 (NRC 1997c), industry initiatives taken during the early 1990s have also contributed to the improved safety of low power and shutdown operation.

E.3.7 Impact from Accidents at Spent Fuel Pools

The 1996 GEIS did not include an explicit assessment of the environmental impacts of accidents at the spent fuel pools (SFPs) located at each reactor site. The 1996 GEIS did, however, discuss qualitatively (see Section 5.2.3.1) the reasons why the impact of accidents at SFPs would be much less than that from reactor accidents. Thus, in Table B-1 of 10 CFR Part 51, it was concluded that accidents at SFPs could be classified as Category 1 and not require further analysis in support of license renewal. This was primarily due to the fact that the resolution of Generic Safety Issue 82, "Beyond Design Basis Accidents in Spent Fuel Pools," concluded that the risk from accidents at SFPs was low and, accordingly, no additional regulatory action was necessary. The analysis supporting this conclusion is contained in NUREG-1353 (NRC 1989).

Since issuance of the 1996 GEIS, additional analysis of the risk from spent fuel pool accidents has been performed and documented. For example, in 2001, the NRC published NUREG-1738 (NRC 2001b), which evaluated SFP risk during decommissioning. As a result of the September 11, 2001, terrorist attacks, additional analysis has been performed on spent fuel pool (SFP) security, although much of this work is security-related information and not publically available. In addition, there are two other major activities of note: (1) a 2004 to 2005 study performed by the National Academies (National Research Council 2006b), and (2) a 2006 Petition for Rulemaking (see NRC 2008d).

The purpose of this section is to consider the risk from severe accidents in SFPs relative to the risk from severe accidents in reactors, including a comparison against the findings in the 1996 GEIS. The impacts considered are only those from spent fuel in the pool. Spent fuel assembly dry cask safety is not included, since cask safety is addressed under 10 CFR Part 72.

E.3.7.1 Airborne Pathway Impacts

The analysis contained in NUREG-1738 (NRC 2001b) assesses the impacts from accidents at a typical SFP at decommissioning nuclear power plants. The impacts assessed are those associated with the airborne pathway impact on human health. The analysis covers a range of decay times for the fuel stored in the pool, a number of initiating events, and some variations in emergency evacuation times, fission product releases, and seismic hazard. The initiating events included in the analysis are listed below.

- Seismic (for central and eastern U.S. sites)[k]
- Cask drop
- Loss of offsite power
- Internal fire

(k) The seismic risk analysis performed in NUREG-1738 was based on site-specific seismic hazard estimates for nuclear power plants in the central and eastern United States found in NUREG-1488, "Revised Livermore Seismic Hazard Estimates for 69 Nuclear Power Plant Sites East of the Rocky Mountains." As such, nuclear power plants in the western United States, such as Diablo Canyon, San Onofre, and Columbia, were not specifically considered in this study. Nothing in NUREG-1738, or the staff's reliance on it here, undermines the staff's initial conclusion in the 1996 GEIS that the impacts of SFP severe accidents will be comparable to reactor severe accidents for all facilities.

- Loss of pool cooling
- Loss of pool coolant inventory
- Accidental aircraft impact (although not deliberate impacts)
- Tornado missile

The SFP inventory assumed was 3½ core loads with an average fuel burnup of 60 GWd/MT. Although intended to be representative of the SFP in a typical decommissioning PWR or BWR, the assumed core inventory, burnup, and decay time range is also reasonably representative of that for operating PWRs and BWRs while at power. In addition to the above results, NUREG-1738 also assessed the risk from recriticality in the SFP and concluded that, given licensee surveillance and monitoring programs, the potential risk of such events is small.

The analysis conducted in NUREG-1738 assumed the plant was in its decommissioning phase and, thus, has fewer protective features for the prevention or mitigation of SFP accidents. Therefore, the impact analysis contained in NUREG-1738 is considered conservative. In addition, the NUREG-1738 impact analysis assumed that the zirconium fuel cladding would start to burn and the event would be nonrecoverable when the water level in the pool falls to within 3 feet (1 m) above the top of the assemblies' active fuel region. This is also conservative and does not credit potential operator actions to prevent or mitigate SFP accidents beyond that point, or the fact that for a wide range of conditions spent fuel can be air-cooled. Table E-18 summarizes the airborne pathway impact on human health from a severe accident in a SFP (from the NUREG-1738 analysis) for a time period of 1 month to 2 years (i.e., a typical operating reactor fuel cycle). Ranges are given to account for differences in emergency planning and seismic hazard assumptions. The site characteristics used in NUREG-1738 were those from the Surry plant. Thus Table E-18 also presents Surry's site-specific results from NUREG-1150 (NRC 1990b) and the 1996 GEIS.

As can be seen in Table E-18, the impacts from SFP accidents at Surry (as calculated in NUREG-1738) are generally comparable to or smaller than the analogous NUREG-1150 internal event reactor accidents when using the low ruthenium release source term.[l] For the high ruthenium release source term, the NUREG-1738 results are generally higher than the accompanying reactor results from NUREG-1150. For either source term, the NUREG-1738

(l) Due to a concern about the potential release of ruthenium isotopes from the spent fuel stored in the SFP, two sensitivity cases were analyzed in NUREG-1738: one with a ruthenium release fraction of 2×10^{-5} (called the base case or the low ruthenium release case) and another with a ruthenium release fraction of 1.0 (called the high ruthenium release case).

Table E-18. Impacts of Accidents at SFPs from NUREG-1738[a]

	Spent Fuel Pools[b] (1 month to 2 years decay time)		**Reactors**		
	NUREG-1738 Low Ru Release (range of means)	**NUREG-1738 High Ru Release (range of means)**	**NUREG-1150 Surry (mean)**	**NUREG-1150 Surry (95th percentile)**	**1996 GEIS Surry (95th percentile)**
Individual risk					
EF[c] (1 mi)	2×10^{-9} to 7×10^{-9}/yr	6×10^{-8} to 1×10^{-7}/yr	1.5×10^{-8}/yr	4×10^{-8}/yr	
LF[d] (10 mi)	1×10^{-8}/yr	2×10^{-7}/yr	1.5×10^{-9}/yr	1×10^{-8}/yr	
Total person-rem per year	2.5 to 12 (50 mi)	8 to 60 (50 mi)	6 (50 mi) 30 (entire region)	30 (50 mi) 150 (150 mi)	1,200 (150 mi)
Total early fatality risk	2×10^{-7} to 6×10^{6}/yr	1×10^{-5} to 5×10^{-4}/yr	1×10^{-6}/yr	3×10^{-6}/yr	1.6×10^{-2}/yr

(a) All values are approximate.
(b) Values are obtained from Figures 3.7-3, 3.7-4, 3.7-7, and 3.7-8 of NUREG-1738.
(c) EF = early fatality risk. The individual early fatality risk within one mile (1.6 km) is the frequency (per year) that a person living within one mile (1.6 km) of the site boundary will die within a year due to the accident. The entire population within one mile (1.6 km) is considered to obtain an average value.
(d) LF = latent fatality risk. The individual latent cancer fatality risk within 10 miles (16 km) is the frequency (per year) that a person living within 10 miles (16 km) of the plant will die many years later from cancer due to radiation exposure received from the accident. The entire population within 10 miles (16 km) is considered to obtain an average value.

impacts are much less than the conservative estimates of full power reactor accidents at Surry as estimated in the 1996 GEIS.

The impacts stated in NUREG-1738 are also similar to those calculated for the resolution of Generic Safety Issue 82, in which NUREG-1353 (NRC 1989) calculated a best-estimate population dose of 16 person-rem per year.[m] While the NUREG-1738 results are for the Surry site, individual risk metrics for early fatalities and latent fatalities should be relatively insensitive to the site-specific population (see pg. 3-28 of NUREG-1738) because these metrics reflect doses to the close-in population. In addition, while results are presented for both the low and high ruthenium source term, the low ruthenium source term is still viewed as the more accurate representation. Therefore, the risk and environmental impact from fires in SFPs as analyzed in NUREG-1738 are expected to be comparable to or lower than those from reactor accidents and are bounded by the 1996 GEIS.

Since the issuance of NUREG-1738 (NRC 2001b), and subsequent to the terrorist attacks of September 11, 2001, significant additional analyses have been performed that support the view that the risk of a successful terrorist attack (i.e., one that results in a zirconium fire) is very low at all plants. These analyses were conducted by the Sandia National Laboratories and are

(m) Taken from the Executive Summary of that report: total dose = 8×10^{6} person-rem; event frequency = 2×10^{-6} per year.

collectively referred to herein as the "Sandia studies." The Sandia studies are sensitive, security-related information and are not available to the public. The Sandia studies considered spent fuel loading patterns and other aspects of a pressurized-water reactor SFP and a boiling-water reactor SFP, including the role that the circulation of air plays in the cooling of spent fuel. The Sandia studies indicated that there may be a significant amount of time between the initiating event (i.e., the event that causes the SFP water level to drop) and the spent fuel assemblies becoming partially or completely uncovered. In addition, the Sandia studies indicated that for conditions where air cooling may not be effective in preventing a zirconium fire, there is a significant amount of time between the spent fuel becoming uncovered and the possible onset of such a zirconium fire, thereby providing a substantial opportunity for both operator and system event mitigation.

The Sandia studies, which more fully account for relevant heat transfer and fluid flow mechanisms, also indicated that air cooling of spent fuel would be sufficient to prevent SFP zirconium fires at a point much earlier following fuel offload from the reactor than previously considered (e.g., in NUREG-1738). Thus, the fuel is more easily cooled, and the likelihood of a zirconium fire is therefore reduced.

Furthermore, additional mitigation strategies implemented subsequent to September 11, 2001, enhance spent fuel coolability and the potential to recover SFP water level and cooling prior to a potential zirconium fire. The Sandia studies also confirmed the effectiveness of these additional mitigation strategies to maintain spent fuel cooling in the event the pool is drained and its initial water inventory is reduced or lost entirely. Based on the more rigorous accident progression analyses, the recent mitigation enhancements, and NRC site evaluations of every SFP in the United States, the risk of an SFP zirconium fire initiation is expected to be less than reported in NUREG-1738 (NRC 2001b) and previous studies. For additional information on SFP safety and security, the reader is referred to the NRC's response to a National Academy of Sciences study on the topic (NRC 2005a) and the NRC's response to a petition for rulemaking (NRC 2008d).

E.3.7.2 Other Pathway Impacts

The NUREG-1738 (NRC 2001b) analysis did not address the impacts with respect to the other pathways (open bodies of water and groundwater). The 1996 GEIS estimated these impacts for reactor accidents from full power (internal events only) using the results from plant-specific reactor accident analysis to assess contamination of open bodies of water and from the Liquid Pathway Generic Study (NUREG-0440; NRC 1978) to assess the contamination of groundwater from basemat melt-through accidents.

In both cases, the impacts on human health from surface water and groundwater contamination are only a small fraction of those impacts from the airborne pathway, except in a few cases where the impacts are comparable. With the impacts from the airborne pathway associated with spent fuel pool accidents (as stated in NUREG-1738) being comparable to the impacts from reactor accidents, as stated in NUREG-1150 (NRC 1990b), the impacts from SFP-related surface water and groundwater contamination may also be comparable, even though the SFP fuel inventory is several times that of the reactor. This is due to the lower probability of occurrence of SFP accidents, the effects of decay of the fission products on the radionuclide inventory, and the lower energy density of the fuel inventory, which makes basemat melt-through more unlikely.

The same conclusion can also be drawn with respect to the economic impacts. These impacts are related to the likelihood of the accidents and the cost of cleanup and food interdiction. Even with higher fuel inventories, the lower likelihood of accidents in the SFP reduces the economic impacts. For example, the UCB economic impact identified in Table 5.31 in the 1996 GEIS from full power reactor accidents at Surry is approximately $1.1 million/yr. The worst-case economic impacts estimated in past studies for SFP accidents ranged from approximately $18,000/yr to $120,000/yr.[n]

An issue related to the groundwater pathway that has received significant attention since the issuance of the 1996 GEIS is leakage of water from SFPs (or related systems) at Salem Unit 1, Indian Point Units 1 and 2, and Seabrook. Instances of this kind are adequately monitored and addressed via existing regulatory programs, and do not fall within the scope of this section. For more information on this topic, the reader is referred to NUREG-0933, Supplement 31, Section 3, Issue 202 (NRC 2007c) and NRC 2008b.

E.3.7.3 Conclusion

In summary, it is concluded that the environmental impacts from accidents at SFPs (as quantified in NUREG-1738 [NRC 2001b]) can be comparable to those from reactor accidents at full power (as estimated in NUREG-1150 [NRC 1990b]). Subsequent analyses performed, and mitigative measures employed since 2001, have further lowered the risk of this class of accidents. In addition, even the conservative estimates from NUREG-1738 are much less than the impacts from full power reactor accidents as estimated in the 1996 GEIS. Therefore, the environmental impacts stated in the 1996 GEIS bound the impact from SFP accidents.

E.3.8 Impact of the Use of BEIR VII Risk Coefficients

Section 5.3.3.2.2 from the 1996 GEIS discussed adverse health effects from exposure to radiation and referenced several National Academy of Sciences reports (BEIR I, III, and V)

(n) The former estimate uses information from Tables C.95 and C.101 of NUREG/BR-0184 (NRC 1997a), while the latter uses information from Tables 5.1.1 and 5.1.2 of NUREG-1353 (NRC 1989).

(National Research Council 1972, 1980, 1990) as sources of risk coefficients for fatal cancers (i.e., latent fatalities) associated with radiation exposure. Benchmark evaluations of the exposure index methodology employed by the 1996 GEIS were conducted using the MELCOR Accident Consequence Code System (MACCS), as described in Section 5.3.3.2.3 of the original GEIS. MACCS is the predecessor of the currently used MACCS2 code, and represented the state-of-the-art for assessing risks associated with postulated severe reactor accidents at the time of the original GEIS. That study used a linear cancer model based on the BEIR V report (National Research Council 1990). The code-to-code comparisons suggest that latent fatality values in the FESs are an order of magnitude too low. Therefore, to account for this, the latent fatality results predicted from the FES values were multiplied by a factor of 10 to obtain the final predicted latent fatality results in the 1996 GEIS. This adjustment in combination with the use of 95th percentile UCB values ensured that the basis for health effects would be conservative.

In 2006, the National Research Council's Committee on the Biological Effects of Ionizing Radiation (BEIR) published BEIR VII, entitled *Health Risks from Exposure to Low Levels of Ionizing Radiation* (National Research Council 2006a). BEIR VII provides estimates of the risk of incidence and mortality for males and females (see Section 3.9.1.4 and Appendix D of this report for more information). The BEIR VII report estimates that the fatal cancer risk coefficient is approximately 20 percent higher than the International Commission on Radiological Protection (ICRP) recommendation (as described in ICRP 1991). The difference of 20 percent is within the margin of uncertainty associated with these estimates (see Appendix D.8.1.4 for a detailed discussion of the BEIR VII report).

The NRC staff completed a review of the BEIR VII report and documented its findings in NRC 2005b. In this paper, the NRC staff concluded that the findings presented in the BEIR VII report agree with the NRC's current understanding of the health risks from exposure to ionizing radiation. The NRC staff agreed with the BEIR VII report's major conclusion that current scientific evidence is consistent with the hypothesis that there is a linear, no-threshold dose response relationship between exposure to ionizing radiation and the development of cancer in humans. This conclusion is consistent with the process the NRC uses to develop its standards of radiological protection. Therefore, the NRC's regulations continue to be adequately protective of public health and safety and the environment. This general topic is discussed further in a 2007 denial of a Petition for Rulemaking, as discussed in NRC 2007d.

E.3.9 Uncertainties

Section 5.3.5 in the 1996 GEIS provides a discussion of the uncertainties associated with the analysis in the GEIS and in the individual plant EISs used to estimate the environmental impacts of severe accidents. The uncertainties discussed covered:

- The probability of an accident.

- The quantity and chemical form of radioactivity released.

- Atmospheric dispersion modeling for the radioactive plume transport, including:
  - duration, energy release, and in-plant radionuclide decay time;
  - meteorological sampling scheme used;
  - emergency response effectiveness and warning time;
  - dose conversion factors and dose-response relationships for early health consequences;
  - dose conversion factors and dose-response relationships for latent health consequences;
  - chronic exposure pathways; and
  - economic data and modeling.

- Assumption of normality for random error components.

- The exposure-index method, and
  - selection of exposure index parameters;
  - selection of distances;
  - regressing early fatalities for only large plants; and
  - normalization of plants for latent fatalities, costs, and dose.

The 1996 GEIS recognized that the uncertainties in the estimated impacts could be large (i.e., from a factor of 10 to 1000). Reference was made to NUREG-1150 (NRC 1990b) as providing more state-of-the-art risk analysis that also considered uncertainties and that the cumulative effect of this analysis shows a reduction in risk.

In an attempt to help compensate for uncertainties, the 1996 GEIS used very conservative estimates of environmental impacts. These included:

- Use of the 95th percentile confidence values in estimating airborne pathway and economic impacts;

- Use of site-specific analysis for estimating surface water pathway impacts; and

- Use of NUREG-0440 (NRC 1978) results to bound the estimated groundwater pathway impacts.

It was generally concluded that even with uncertainties, the environmental impacts estimated in the 1996 GEIS were adequate for use.

Many of these same uncertainties also apply to the analysis used in this update. However, as discussed in Sections E.3.1 through E.3.8 of this revision, more recent information is used to supplement the estimate of the environmental impacts contained in the 1996 GEIS. In effect, the assessments contained in Sections E.3.1 through E.3.8 of this revision provide additional information and insights into items that could be considered areas of uncertainty associated with the 1996 GEIS.

This more recent information also provides insights on additional sources of uncertainty from those discussed in the 1996 GEIS. Each of these insights on additional sources of uncertainty is discussed below.

E.3.9.1 Emergency Planning (EP)

The 1996 GEIS (in Section 5.3.5.3) included a discussion on uncertainties associated with EP. However, no quantitative information on the magnitude of these uncertainties was presented. To provide a perspective on the magnitude of the uncertainty, the following information is provided.

NUREG-1150 (NRC 1990b) and the SFP accident analysis in NUREG-1738 (NRC 2001b) specifically assessed the effect of different EP assumptions on the airborne pathway impacts. NUREG-1150 assessed four alternative emergency response modes in addition to its base case (99.5 percent of the population within 10 mi was evacuated in 4.5 hours with no sheltering). These alternatives were assessed for reactor accidents from full power, with the Surry and Peach Bottom analyses including seismic and fire initiated events as well as internal events. For the worst case (no evacuation, no sheltering, and early relocation), the estimated early fatalities per year were approximately a factor of 10 higher than the base case.

The SFP accident analysis in NUREG-1738 also specifically assessed the effect of variations in emergency evacuation. The variations were assessed against the base case used in the NUREG-1150 risk analysis. Doses beyond 20 mi were not calculated. Cases where the evacuation was faster, slower, and where fewer people were evacuated were assessed. As can be expected, improved evacuation scenarios resulted in smaller impacts, and relaxed evacuation scenarios resulted in additional impacts. The impacts associated with relaxed evacuation scenarios did go up, but only a few percent in societal dose (i.e., person-rem) and up to a factor of 10 in early fatalities. However, these impacts are still far below the conservative characterization of the impacts for reactor accidents contained in the original GEIS.

E.3.9.2 Population Increase

The assessments of environmental impacts contained in NUREG-1150 (NRC 1990b), NUREG-1738 (NRC 2001b), NUREG-1449 (NRC 1993), NUREG/CR-5305 (NRC 1992), NUREG/CR-6143 (NRC 1995b) and NUREG/CR-6144 (NRC 1995a) are all based on populations that existed in the mid-1980s to mid-1990s. The 1996 GEIS estimated impacts at the mid-year of each plant's license renewal period (i.e., 2030 to 2050). To adjust the impacts estimated in the NUREGs and NUREG/CRs to the mid-year of the assessed plant's license renewal period, the information (i.e., exposure indexes [EIs]) in the 1996 GEIS can be used. The EIs adjust a plant's airborne and economic impacts from the year 2000 to its mid-year license renewal period based on population increases. These adjustments result in anywhere from a 5 to a 30 percent increase in impacts, depending upon the plant being assessed. Given the range of uncertainty in these types of analyses, a 5 to 30 percent change is not considered significant. Therefore, the effect of increased population around the plant does not generally result in significant increases in impacts.

E.4 Severe Accident Mitigation Alternatives (SAMAs)

In Section 5.4 of the 1996 GEIS, the purpose and role of severe accident mitigation design alternatives (SAMDAs) in the license renewal process are discussed. Severe accident mitigation alternatives (SAMAs) include design alternatives (SAMDAs) and alternatives that involve changes in procedures and training. With respect to this revision of the GEIS, the purpose and objectives of SAMAs remain unchanged.

The purpose of this section is to discuss the impacts on SAMA analyses of the assessments presented in this revision. It should be noted that since publication of this 1996 GEIS, many improvements have occurred that have enhanced reactor safety. These are discussed in Section E.2 of this revision and, as can be seen in improved plant performance measures, have been effective. Even so, the SAMA analyses that have been performed to date have found SAMAs that were cost-beneficial, or at least possibly cost-beneficial subject to further analysis, in approximately half of the plants. However, none of the SAMAs identified related to managing the effects of aging during the period of extended operation. Therefore, they did not need to be implemented as part of license renewal, pursuant to the regulations in 10 CFR Part 54. In general, the cost-beneficial SAMAs were identified for further evaluation by the licensee under the current operating license. In several cases, the applicant has decided to implement the modifications even though they were not related to license renewal (NRC 2006a).

The SAMA analysis performed in support of license renewal has focused on those areas of greatest risk (accidents initiated by internal and external events) and on measures that could result in the greatest risk reduction in a cost-beneficial fashion. Even though the 1996 GEIS did not explicitly consider accidents initiated by external events in estimating the environmental impacts from severe accidents, the environmental impacts from external events are included in an applicant's SAMA analysis for license renewal by following the guidance contained in NEI 05-01, Revision A (NEI 2005). This guidance (which is endorsed by the NRC in Regulatory Guide 4.2, Supplement 1, Revision 1, "Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications," [NRC 2013]) calls for the consideration of external events in assessing SAMAs. External events are considered by multiplying the internal event risk by a factor that accounts for any increase in risk caused by external events. The multiplication factor is determined on a plant-specific basis considering previous and current external event analyses (e.g., IPEEE). Given the existing information on the contribution to risk from external events, the approach described in NEI 05-01 continues to be a reasonable approach to address the external event risk contribution.

This GEIS revision has assessed other potential contributors to risk. Therefore, it is reasonable to assess whether those contributors should be included in the SAMA analysis. Specifically, these contributors are:

- Power uprates;
- The use of higher burnup fuel;
- Accidents from low power and shutdown conditions; and
- Accidents at SFPs.

With respect to power uprates and the use of higher burnup fuel, the increased impacts are small compared to the impacts in the 1996 GEIS, and these factors are included in any severe accident assessment for license renewal. Therefore, no additional SAMA analysis is required.

With respect to accidents from low power and shutdown conditions (which are not currently included in SAMA analysis), the CDFs are generally lower and the risks are comparable to those of accidents from full power. In addition, there have been industry initiatives to improve low power and shutdown safety. It is also likely that some SAMAs identified as a result of assessing risks from accidents at full power would provide benefits to accidents from low power. Therefore, the potential for cost-beneficial SAMAs related to low power and shutdown accidents is considered to be less than for accidents at full power. Accordingly, it is reasonable to continue to exclude low power and shutdown conditions from SAMA analysis consideration.

With respect to accidents in SFPs, the additional mitigative measures implemented following the attacks of September 11, 2001, have further lowered the risk of this class of accidents, and therefore make the potential for finding cost-effective SAMAs related to SFP accidents substantially less than for reactor accidents. Therefore, it is reasonable to conclude that accidents at SFPs do not need to be considered in the SAMA analysis.

With respect to which plants must submit a SAMA analysis, 10 CFR 51.53(c)(3)(ii)(L) states that, "[i]f the staff has not previously considered severe accident mitigation alternatives for the applicant's plant, in an environmental impact statement or related supplement or in an environmental assessment, a consideration of alternatives to mitigate severe accidents must be provided." Applicants for plants that have already had a SAMA analysis considered by the NRC as part of an EIS, supplement to an EIS, or EA, do not need to have a SAMA analysis reconsidered for license renewal. In forming its basis for determining which plants needed to submit a SAMA, the Commission noted that all licensees had undergone, or were in the process of undergoing, more detailed site-specific severe accident mitigation analyses through processes separate from license renewal, specifically the Containment Performance Improvement (CPI), Individual Plant Examination (IPE), and IPE for external events (IPEEE) programs (61 FR 28467). In light of these studies, the Commission stated that it did not expect future SAMA analyses to uncover "major plant design changes or modifications that will prove to be cost-beneficial." (61 FR 28467). The NRC's experience in completed license renewal proceedings has confirmed this prediction. As a result, the totality of these studies (the former SAMA analyses, the IPE, the IPEEE, and the CPI) provides a strong basis for the Commission's decision to not require applicants to perform an additional SAMA analysis in a license renewal application if the NRC had previously evaluated one for that plant. Therefore, applicants for license renewal of those plants that have already had a SAMA analysis considered by the NRC as part of an EIS, supplemental to an EIS or EA, need not perform an additional SAMA analysis for license renewal.

E.5 Summary and Conclusion

The 1996 GEIS estimated the environmental impacts on human health and economic factors from full power severe reactor accidents initiated by internal events. Sections E.3.1 through E.3.8 of this revision assessed the impacts of new information and additional accident considerations on the environmental impact of severe accidents contained in the 1996 GEIS. In addition, the impact of uncertainties associated with the new information is assessed in Section E.3.9. The purpose of this section is to discuss the aggregate effect of the new information on the environmental impacts and uncertainties stated in the 1996 GEIS and to state what conclusions can be drawn.

The different sources of new information can be generally categorized by their effect of decreasing, not affecting, or increasing the best-estimate environmental impacts associated with postulated severe accidents. Those areas where a decrease in best-estimate impacts would be expected are:

- New internal events information (decreases by an order of magnitude)
- New source term information (significant decreases)

Areas likely leading to either a small change or no change include:

- Use of BEIR VII risk coefficients

Lastly, those areas leading to an increase in best-estimate impacts would consist of:

- Consideration of external events (comparable to internal event impacts)
- Power uprates (small to moderate increase)
- Higher fuel burnup (small to moderate increases)
- Low power and shutdown events (could be comparable to full power event impacts)
- Spent fuel pool accidents (could be comparable to full power event impacts)

Given the difficulty in conducting a rigorous aggregation of these results (due to the differences in the information sources utilized), a fairly simple approach is taken. The latter group contains three areas where the increase could be comparable to the current risk and two areas where the increase could approach 30 to 40 percent. The net increase from these five areas would therefore be approximately 470 percent[o] (increase by a factor of 4.7). The reduction in risk due to newer internal event information would account for a decrease by a factor of 5 to 100. The net effect of an increase on the order of 500 percent and a decrease on the order of 500 percent to 10,000 percent would be a reduction in estimated impacts (as compared to the 1996 GEIS assessment).

Furthermore, even if one assumed that the net effect of the new information was no change in risk, the information provided throughout this appendix has demonstrated that the level of conservatism in the upper bound estimates utilized in the 1996 GEIS is much larger than the individual (or cumulative) deltas from the updated information. In particular, Section E.3.1 demonstrates that the GEIS values were a factor of 2 to 4 higher than the underlying EIS values.

(o) This approximation simply assumes that each comparable area results in an increase of 100 percent and the other two areas (uprates and burnup) each result in an increase of 35 percent.

With respect to uncertainties, the 1996 GEIS contained an assessment of uncertainties in the information used to estimate the environmental impacts. Section 5.3.5 of the 1996 GEIS discusses the uncertainties and concludes that they could cause the impacts to vary anywhere from a factor of 10 to a factor of 1,000. This range of uncertainties bounds the uncertainties discussed in Section E.3.9 above, which ranged from a factor of 3 to 10, as well as the uncertainties brought in by the other sources of new information.

Given the discussion in this appendix, the staff concludes that the reduction in environmental impacts from the use of new information (since the 1996 GEIS analysis) outweighs any increases resulting from this same information. As a result, the findings in the 1996 GEIS remain valid. Therefore, design-basis accidents remain a Category 1 issue, and although the probability-weighted consequences of severe accidents are SMALL for all plants, severe accidents remain a Category 2 issue to the extent that only the alternatives to mitigate severe accidents must be considered for all plants that have not previously considered such alternatives.

In addition, it is reasonable that in license renewal applications, the impacts from reactor accidents at full power, including internal and external events, should continue to be considered in assessing SAMAs. The impacts of all other new information do not contribute sufficiently to the environmental impacts to warrant their inclusion in the SAMA analysis since the likelihood of finding cost-effective plant improvements is small. Alternatives to mitigate severe accidents still must be considered for all plants that have not considered such alternatives. Table E-19 provides a summary of the conclusions discussed above.

Table E-19. Summary of Conclusions

Topic (Section)	Conclusions
New Internal Events Information (Section E.3.1)	New information on the risk and environmental impacts of severe accidents caused by internal events indicates that PWR and BWR CDFs are generally comparable to or less than those forming the basis of the 1996 GEIS. In some cases, these differences are significant (approaching one order of magnitude). Comparison of population dose from newer assessments illustrates a reduction in impact by a factor of 5 to 100 when compared to older assessments, and an additional factor of 2 to 4 due to the conservatism built into the 1996 GEIS values. This would also mean that contamination of open bodies of water and economic impacts would, in most cases, be significantly less. Additionally, the likelihood of basemat melt-through accidents is less than that used in the analysis supporting the 1996 GEIS.
Consideration of External Events (Section E.3.2)	The 1996 GEIS did not quantitatively consider severe accidents initiated by external events in assessing environmental impacts. When the environmental impacts of external events are considered, they can be comparable to those from internal events; however, they are generally lower than the estimates used in the 1996 GEIS for internal events. This conclusion would also apply to the contamination of open bodies of water and groundwater and economic impacts.

Table E-19. (cont.)

Topic (Section)	Conclusions
New Source Term Information (Section E.3.3)	More recent source term information indicates that the timing from dominant severe accident sequences, as quantified in NUREG/CR-6295, is comparable to the analysis forming the basis of the 1996 GEIS. In most cases, the release frequencies and release fractions are significantly lower for the more recent estimate. Thus, the environmental impacts used as the basis for the 1996 GEIS are higher than the impacts that would be estimated using the more recent source term information.
Power Uprates (Section E.3.4)	Based on a comparison of the change in LERF for extended power uprates, a small to moderate increase in environmental impacts results from the increase in operating power level.
Higher Fuel Burnup (Section E.3.5)	Increased peak fuel burnup from 42 to 75 GWd/MT for PWRs, and 60 to 75 GWd/MT for BWRs, is estimated to result in small to moderate increases in the environmental impacts in the event of a severe accident.
Consideration of Low Power and Shutdown Events (Section E.3.6)	The environmental impacts from accidents at low power and shutdown conditions are generally comparable to those from accidents at full power when comparing the values in NUREG/CR-6143 and NUREG/CR-6144 to those in NUREG-1150. Even so, the 1996 GEIS estimates of the environmental impact of severe accidents bound the potential impacts from accidents at low power and shutdown. Finally, as cited above and discussed in SECY-97-168, industry initiatives taken during the early 1990s have also contributed to the improved safety of low power and shutdown operation.
Consideration of Spent Fuel Pool Accidents (Section E.3.7)	The environmental impacts from accidents at SFPs (as quantified in NUREG-1738) can be comparable to those from reactor accidents at full power (as estimated in NUREG-1150). Subsequent analyses performed, and mitigative measures employed, since 2001 have further lowered the risk of this class of accidents. In addition, the conservative estimates from NUREG-1738 are much less than the impacts from full power reactor accidents that are estimated in the 1996 GEIS.
Use of BEIR VII Risk Coefficient (Section E.3.8)	Use of newer risk coefficients such as in BEIR VII is expected to have a small impact on the results presented in the 1996 GEIS.
Uncertainties (Section E.3.9)	The impact and magnitude of uncertainties, as estimated in the 1996 GEIS, bound the uncertainties introduced by the new information and considerations.
SAMAs (Section E.4)	The current process and scope of SAMA analysis are sufficient for determining the need for additional mitigative measures.
Summary and Conclusion (Section E.5)	Given the new and updated information, the reduction in estimated environmental impacts from the use of new internal event and source term information outweighs any increases from the consideration of external events, power uprates, higher fuel burnup, low power and shutdown risk, and SFP risk.

NUCLEAR REGULATORY COMMISSION

10 CFR Part 51

RIN 3150–AI42

[NRC–2008–0608]

Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses

AGENCY: Nuclear Regulatory Commission.

ACTION: Final rule.

SUMMARY: The U.S. Nuclear Regulatory Commission (NRC) is amending its environmental protection regulations by updating the Commission's 1996 findings on the environmental effect of renewing the operating license of a nuclear power plant. The final rule redefines the number and scope of the environmental impact issues that must be addressed by the NRC during license renewal environmental reviews. This final rule also incorporates lessons learned and knowledge gained from license renewal environmental reviews conducted by the NRC since 1996.

DATES: This rule is effective on July 22, 2013. However, compliance is not required until June 20, 2014.

ADDRESSES: Please refer to Docket ID NRC–2008–0608 when contacting the NRC about the availability of information for this final rule. You may access information and comment submittals related to this final rulemaking, which the NRC possesses and is publicly available, by the following methods:

- *Federal Rulemaking Web site:* Go to *http://www.regulations.gov* and search for Docket ID NRC–2008–0608. Address questions about NRC dockets to Carol Gallagher; telephone: 301–492–3668; email: *Carol.Gallagher@nrc.gov.* For technical questions, contact the individuals listed in the **FOR FURTHER INFORMATION CONTACT** section of this final rule.
- *NRC's Agencywide Documents Access and Management System (ADAMS)*: You may access publicly available documents online in the NRC Library at *http://www.nrc.gov/reading-rm/adams.html.* To begin the search, select ''*ADAMS Public Documents*'' and then select ''*Begin Web-based ADAMS Search.*'' For problems with ADAMS, please contact the NRC's Public Document Room (PDR) reference staff at 1–800–397–4209, 301–415–4737, or by email to *pdr.resource@nrc.gov.* The ADAMS accession number for each document referenced in this notice (if that document is available in ADAMS) is provided the first time that a document is referenced. In addition, for the convenience of the reader, the ADAMS accession numbers are provided in a table in Section XII, ''Availability of Documents,'' of this document.
- *NRC's PDR:* You may examine and purchase copies of public documents at the NRC's PDR, One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852.

FOR FURTHER INFORMATION CONTACT: Mr. Stewart Schneider, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001; telephone: 301–415–4123; email: *Stewart.Schneider@nrc.gov;* or Mr. Jeffrey Rikhoff, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001; telephone: 301–415–1090; email: *Jeffrey.Rikhoff@nrc.gov.*

Executive Summary

Purpose of the Regulatory Action

The Atomic Energy Act of 1954 authorizes the NRC to issue commercial nuclear power plant operating licenses for up to 40 years. The NRC's regulations allow for the renewal of these operating licenses for up to an additional 20 years. The license renewal process includes reviewing a license renewal application, conducting the assessment, and then, if all applicable safety standards are met, renewing the license. The NRC's review of a license renewal application proceeds along two independent regulatory tracks: one for safety issues and another for environmental issues. The license renewal process is defined by a clear set of regulations that are designed to ensure safe operation and protection of the environment during the license renewal term. The NRC's regulations for the license renewal safety review are set forth in Part 54 of Title 10 of the *Code of Federal Regulations* (10 CFR). The NRC's environmental protection regulations are set forth in 10 CFR part 51.

The renewal application is the principal document that an applicant provides to both request and support renewal for a nuclear power reactor's operating license. The license renewal application includes both general and technical information that demonstrates that an applicant is in compliance with the NRC's regulations in 10 CFR part 54. During the renewal process, the license renewal applicant must confirm whether the design assumptions used for the original licensing basis will continue to be valid throughout the period of extended operation and that the aging effects will be adequately managed. The applicant must demonstrate that the effects of aging will be managed in such a way that the intended functions of ''passive'' or ''long-lived'' structures and components (such as the reactor vessel, reactor coolant system, piping, steam generators, pressurizer, pump casings, and valves) will be maintained during the license renewal term (also known as the period of extended operation). For active components, such as motors, diesel generators, cooling fans, batteries, relays, and switches, the Commission's ongoing regulatory oversight programs already ensure that the components continue to perform their intended function during the period of license renewal. This information must be sufficiently detailed in the application to permit the NRC staff to determine if the applicant's management of these issues is adequate to allow operation during the extended period of operation without undue risk to the public and workers' health and safety.

In addition to the safety assessment, the applicant must also prepare an evaluation of the potential impacts to the environment of facility operation for an additional 20 years. Under the NRC's environmental protection regulations in 10 CFR part 51, which implement the National Environmental Policy Act (NEPA), renewal of a nuclear power plant operating license requires the preparation of an environmental impact statement (EIS). To support the preparation of these EISs, the NRC issued a rule in 1996 to define which impacts would essentially be the same at all nuclear power plants (Category 1 issues) and which ones could be different at different plants and would require a plant-specific analysis to determine the impacts (Category 2 issues). For each license renewal application, those impacts that require a plant-specific analysis must be analyzed by the applicant in its environmental report and by the NRC in its associated EIS. The final rule amends those regulations by updating the Commission's 1996 rule. The final rule redefines the number and scope of the environmental impact issues that must be addressed by the NRC and applicants during license renewal environmental reviews. These changes are based primarily on lessons learned and knowledge gained from license renewal environmental reviews conducted by the NRC since 1996.

The NRC prepared a regulatory analysis to determine the expected quantitative and qualitative costs and benefits of the final rule. The analysis concluded that the final rule will result in net savings to the industry and the NRC. For more information, please see the regulatory analysis (ADAMS Accession No. ML110760321).

Summary of the Major Rule Changes

In the 1996 rule, there were 92 environmental impact issues, 23 of which required a plant-specific analysis (Category 2 issues) during license renewal environmental reviews. In the final rule, there are 78 environmental impact issues, 17 of which require a plant-specific analysis. The following bullets summarize the major changes to the rule:

- Based on the related nature of the issues, several Category 1 issues were consolidated with other Category 1 issues. This includes some issues that were changed from Category 2 to Category 1 and subsequently combined with other, related Category 1 issues. Similarly, several Category 2 issues were combined with related Category 2 issues.
- New Category 1 issues were added: geology and soils; effects of dredging on surface water quality; groundwater use and quality; exposure of terrestrial organisms to radionuclides; exposure of aquatic organisms to radionuclides; effects of dredging on aquatic organisms; impacts of transmission line right-of-way management on aquatic resources; employment and income; tax revenues; human health impacts from chemicals; and physical occupational hazards.
- Several issues were changed from Category 2 to Category 1: Offsite land use, air quality, public services (several issues), and population and housing.
- New Category 2 issues were added: Radionuclides released to groundwater, water use conflicts with terrestrial resources, water use conflicts with aquatic resources, and cumulative impacts.
- One uncharacterized issue was reclassified as Category 2: Environmental justice/minority and low-income populations.
- One Category 1 issue was revised to narrow the scope of its finding due to the United States Court of Appeals for the District of Columbia Circuit (D.C. Circuit) decision in *New York* v. *NRC,* 681 F.3d 471 (D.C. Cir. 2012), which vacated the NRC's 2010 Waste Confidence Decision and Rule (75 FR 81032 and 81037; December 23, 2010): Onsite storage of spent nuclear fuel.
- One Category 1 issue was reclassified as uncategorized due to the *New York* v. *NRC* decision: Offsite radiological impacts of spent nuclear fuel and high-level waste disposal.

SUPPLEMENTARY INFORMATION:

I. Background

Rulemaking History

In 1986, the NRC initiated a program to develop license renewal regulations and associated regulatory guidance in anticipation of receiving applications for the renewal of nuclear power plant operating licenses. In 1996, the NRC published a final rule that amended the environmental protection regulations in 10 CFR part 51 for applicants seeking to renew an operating license for up to an additional 20 years.[1] The 1996 final rule was based upon the analyses and findings of a May 1996 NRC environmental impact statement, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants,'' NUREG–1437 (the ''1996 GEIS'') (Vol. 1, ''Main Report,'' ADAMS Accession No. ML040690705; Vol. 2, ''Appendices,'' ADAMS Accession No. ML040690738).

Based upon the findings of the 1996 GEIS, the 1996 final rule identified those license renewal environmental impact issues for which a generic analysis had been determined to be appropriate and therefore, did not have to be addressed by a license renewal applicant in its plant-specific environmental report or by the NRC in its plant-specific supplemental environmental impact statements (SEISs) to the 1996 GEIS. Similarly, based upon the findings of the 1996 GEIS, the 1996 final rule identified those environmental impacts for which a site- or plant-specific analysis was required, both by the applicant in its environmental report and by the NRC in its SEIS. The 1996 final rule, amongst other amendments to 10 CFR part 51, added Appendix B to Subpart A of 10 CFR part 51, ''Environmental Effect of Renewing the Operating License of a Nuclear Power Plant.'' Appendix B included Table B–1, ''Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants,'' which summarized the findings of the 1996 GEIS.

In preparing the 1996 GEIS, the Commission determined that certain environmental impacts associated with the renewal of a nuclear power plant operating license were the same or similar for all plants and, as such, could be treated on a generic basis. In this way, repetitive reviews of these environmental impacts could be avoided. The Commission based its generic assessment of certain environmental impacts on the following factors:

(1) License renewal will involve nuclear power plants for which the environmental impacts of operation are well understood as a result of lessons learned and knowledge gained from operating experience and completed license renewals.

(2) Activities associated with license renewal are expected to be within this range of operating experience; thus, environmental impacts can be reasonably predicted.

(3) Changes in the environment around nuclear power plants are gradual and predictable.

The 1996 GEIS improved the efficiency of the license renewal process by: (1) Providing an evaluation of the types of environmental impacts that may occur from renewing commercial nuclear power plant operating licenses; (2) identifying and assessing impacts that are expected to be generic (i.e., the same or similar) at all nuclear power plants or plants with specified plant or site characteristics; and (3) defining the number and scope of environmental impacts that need to be addressed in plant-specific SEISs to the 1996 GEIS.

In short, the 1996 final rule identified environmental impact issues (i.e., Category 1 issues)[2] that do not have to

[1] 61 FR 28467 (June 5, 1996).

[2] A Category 1 issue is one that meets the following criteria: (1) The environmental impacts

Continued

be addressed by licensees in environmental reports for nuclear power plant license renewal applications or by the NRC in plant-specific SEISs because these issues have been addressed generically for all nuclear power plants in the 1996 GEIS. Similarly, the 1996 final rule also identified environmental impact issues (i.e., Category 2 issues) [3] that must be addressed in plant-specific reviews by licensees in their environmental reports and by the NRC in the SEISs.

On December 18, 1996 (61 FR 66537), the NRC amended the final rule published in 1996 to incorporate minor clarifying and conforming changes and to add language omitted from Table B–1 in Appendix B to Subpart A of 10 CFR part 51 (hereafter ''Table B–1 in Appendix B to Subpart A of 10 CFR Part 51'' is referred to as ''Table B–1'').

1999 Final Rule

The NRC amended 10 CFR part 51, including Table B–1, on September 3, 1999 (64 FR 48496). This amendment expanded the generic findings pertaining to the environmental impacts resulting from transportation of fuel and waste to and from a single nuclear power plant. This amendment also incorporated rule language consistent with the 1996 GEIS, which addressed local traffic impacts attributable to the continued operations of a nuclear power plant during the license renewal term.

Current Rulemaking

As stated in the 1996 final rule that incorporated the findings of the GEIS in 10 CFR part 51, the NRC recognized that environmental impact issues might change over time and that additional issues may need to be considered. As further stated in the preamble to Table B–1, the NRC indicated that it intended to review the material in Table B–1 on a 10-year basis.

The NRC began this review on June 3, 2003, by publishing a notice of intent to revise the 1996 GEIS (68 FR 33209). As part of this process and pursuant to 10 CFR 51.29, the NRC conducted scoping and held a series of public meetings (*see* 74 FR 38119 for more details). The original public comment period began in June 2003 and closed in September 2003. The project was inactive for the next 2 years due to limited NRC staff resources and competing demands. On October 3, 2005 (70 FR 57628), the NRC reopened the public comment period and extended it until December 30, 2005.

On July 31, 2009 (74 FR 38117), the NRC published the proposed rule, ''Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses,'' for public comment in the **Federal Register**. The proposed rule would amend Table B–1 by updating the Commission's 1996 findings on the environmental impacts related to the renewal of nuclear power plant operating licenses and other NRC environmental protection regulations (e.g., 10 CFR 51.53, which sets forth the contents of the applicant's environmental report). Together with the proposed rule, the NRC also published a notice of availability of the draft revised GEIS (ADAMS Accession No. ML090220654); a proposed Revision 1 of Regulatory Guide (RG) 4.2, Supplement 1, ''Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications'' (ADAMS Accession No. ML091620409); and a proposed Revision 1 to NUREG–1555, Supplement 1, ''Standard Review Plans for Environmental Reviews for Nuclear Power Plants'' (ADAMS Accession No. ML090230497), in the **Federal Register** (74 FR 38238). All of the documents requested public comments.

The proposed amendments were based on consideration of (1) Comments received from the public during the public scoping period, (2) a review of comments received on plant-specific SEISs completed since the 1996 GEIS was issued, and (3) lessons learned and knowledge gained from previous and ongoing license renewal environmental reviews. The history of this rulemaking is discussed in more detail in the July 31, 2009 (74 FR 38117), proposed rule. The draft revised GEIS provided the regulatory basis for the July 2009 proposed rule.

The proposed rule provided a 75-day public comment period, which closed on October 14, 2009. The NRC received requests to extend the comment period to provide the public more time to analyze and review the legal, regulatory, and policy issues covered by the proposed rule and supporting documents. On October 7, 2009 (74 FR 51522), the NRC granted the requests, and the public comment period for the proposed rule and the proposed revisions to the GEIS, the regulatory guide, and standard review plan was extended to January 12, 2010.

II. Public Meetings

During the public comment period, the NRC conducted six public meetings to solicit comments on the proposed rule, draft revised GEIS, and related draft guidance documents. The official transcripts, written comments, and meeting summaries for the following public meetings are available electronically for public inspection at the NRC's PDR or online in the NRC Library at *http://www.nrc.gov/reading-rm/adams.html:*

(1) September 15, 2009, Atlanta, GA (ADAMS Accession No. ML092810007);
(2) September 17, 2009, Newton, MA (ADAMS Accession No. ML092931681);
(3) September 24, 2009, Oak Brook, IL (ADAMS Accession No. ML092931545);
(4) October 1, 2009, Rockville, MD (ADAMS Accession No. ML092931678);
(5) October 20, 2009, Pismo Beach, CA (ADAMS Accession No. ML093070174); and
(6) October 22, 2009, Dana Point, CA (ADAMS Accession No. ML093100505).

A summary of these meetings is publicly available under ADAMS Accession No. ML093070141.

On June 21, 2011, the NRC conducted another public meeting to discuss final rule implementation in Rockville, MD. No public comments were solicited at this meeting because the public comment period for the proposed rule had closed on January 12, 2010. A summary of this meeting is publicly available in ADAMS under Accession No. ML11182B535.

III. Discussion

1996 GEIS

Under the NRC's environmental protection regulations in 10 CFR part 51, which implements Section 102(2) of NEPA, renewal of a nuclear power plant operating license requires the preparation of an EIS (*see* 10 CFR 51.20(b)(2)). The 1996 GEIS summarized the findings of a systematic inquiry into the environmental impacts of continued operations and refurbishment activities associated with license renewal. Of the 92 environmental issues identified and analyzed by the NRC, 69 issues were determined to be generic (i.e., Category 1); 21 were determined to be plant-specific (i.e., Category 2); and two did not fit into either category (i.e., uncategorized). Category 1 issues concern those potential environmental impacts resulting from license renewal that are common or generic to all

associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic; (2) a single significance level (i.e., small, moderate, or large) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal); and (3) mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

[3] A Category 2 issue is one where one or more of the Category 1 criteria cannot be met, and therefore additional plant-specific review is required.

nuclear power plants (or for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic). Category 2 issues concern those potential environmental impacts resulting from license renewal that are not common or generic to all nuclear power plants and, as such, require a plant-specific analysis to determine the level of impact. The two uncategorized issues would be addressed by the NRC in each SEIS. Table B–1 summarizes the findings of the environmental impact analyses conducted for the 1996 GEIS and lists each issue and its category level.

Impact levels (small, moderate, or large) were determined for most NEPA issues (e.g., land use, air, water) evaluated in the 1996 GEIS. A small impact means that the environmental effects are not detectable, or are so minor that they would neither destabilize nor noticeably alter any important attribute of the resource. A moderate impact means that the environmental effects are sufficient to alter noticeably, but not destabilize, important attributes of the resource. A large impact means that the environmental effects would be clearly noticeable and would be sufficient to destabilize important attributes of the resource.

The 1996 GEIS has been effective in focusing the NRC's resources on important license renewal environmental impact issues and has increased the efficiency of the environmental review process. Currently, 73 nuclear units at 43 plant sites have received renewed operating licenses.

Revised GEIS

The revised GEIS (Vol. 1, ''Main Report,'' ADAMS Accession No. ML13106A241; Vol. 2, ''Public Comments,'' ADAMS Accession No. ML13106A242; and Vol. 3, ''Appendices,'' ADAMS Accession No. ML13106A244) is both an update and a re-evaluation of the potential environmental impacts arising from the renewal of an operating license for a nuclear power reactor for an additional 20 years. Lessons learned and knowledge gained during previous license renewal environmental reviews provided a significant source of new information for the revised GEIS. In addition, public comments received during previous license renewal environmental reviews were re-examined to validate existing environmental issues and identify new ones. In preparing the revised GEIS, the NRC considered the need to modify, add to, consolidate, or delete any of the 92 environmental issues evaluated in the 1996 GEIS.

In the proposed rule and draft revised GEIS, the NRC carried forward 78 environmental impact issues for detailed consideration. Fifty-eight of these issues were determined to be Category 1. Of the remaining 20 issues, 19 were determined to be Category 2 and one issue, ''Electromagnetic fields, chronic effects,'' remained uncategorized.[4] These issues were summarized in the July 31, 2009 (74 FR 38117), proposed rule.

Based on public comments received on the proposed rule and draft revised GEIS, a number of the environmental impact issues identified in the proposed rule were re-evaluated for detailed consideration in the final revised GEIS and are reflected in the changes made by the final rule. These changes are discussed in detail in Section VIII, ''Final Actions and Basis for Changes to Table B–1,'' of this document and are briefly summarized as follows:

(1) ''Air quality during refurbishment (nonattainment and maintenance areas)'' issue was changed from a Category 2 to a Category 1 issue and renamed, ''Air quality impacts (all plants).''

(2) ''Groundwater and soil contamination'' issue was changed from a Category 2 to a Category 1 issue and consolidated with the ''Groundwater use and quality'' issue into a single renamed Category 1 issue, ''Groundwater contamination and use (non-cooling system impacts).''

(3) ''Thermal impacts on aquatic organisms'' issue was changed to remove several Category 1 thermal impacts issues (these Category 1 issues were consolidated together with a Category 2 thermal impact issue in the proposed rule) to create a new separate combined Category 1 issue, ''Infrequently reported thermal impacts (all plants),'' which also includes the previously separate ''Stimulation of aquatic nuisance species (e.g., shipworms),'' Category 1 thermal impact issue.

(4) ''Impingement and entrainment of aquatic organisms'' issue was changed to remove a single impingement and entrainment Category 1 issue (consolidated with other impingement and entrainment issues in the proposed rule) to create a new, separate Category 1 issue, ''Entrainment of phytoplankton and zooplankton (all plants).''

In addition to the changes previously discussed, the NRC has made changes to the ''Onsite storage of spent nuclear fuel'' issue and the ''Offsite radiological impacts of spent nuclear fuel and high-level waste disposal'' issue as a result of the United States Court of Appeals decision in *New York* v. *NRC,* 681 F.3d 471 (D.C. Cir. 2012), which vacated the NRC's 2010 Waste Confidence Decision and Rule (75 FR 81032 and 81037; December 23, 2010). The Category 1 ''Onsite storage of spent nuclear fuel'' issue was revised to limit the period of time covered by the issue to the license renewal term. Similarly, the NRC revised the Category 1 issue, ''Offsite radiological impacts of spent nuclear fuel and high-level waste disposal'' by reclassifying the issue from a Category 1 issue with an impact level of small to an uncategorized issue with an impact level of uncertain. Section V of this document, ''Related Issues of Importance,'' provides further details on the NRC's revisions to these issues in response to the *New York* v. *NRC* decision.

Ultimately, 59 environmental impact issues were determined to be Category 1 and would not require additional plant-specific analysis unless new and significant information is identified during the license renewal environmental review. Of the remaining 19 issues, 17 were determined to be Category 2, one remained uncategorized with respect to determining the impact level (''Chronic effects of electromagnetic fields (EMFs)''), and one was reclassified from Category 1 to uncategorized (''Offsite radiological impacts of spent nuclear fuel and high-level waste disposal''). These 78 issues were evaluated in the revised GEIS and are summarized in the final rule. No environmental issues identified in Table B–1 and evaluated in the 1996 GEIS were eliminated, but certain issues were consolidated or grouped according to similarities.

Environmental issues in the revised GEIS are arranged by resource area. This perspective is a change from the 1996 GEIS in which environmental issues are arranged by power plant systems (e.g., cooling systems, transmission lines) and activities (e.g., refurbishment). The structure of the revised GEIS conforms to the NRC's standard format for EISs found in Appendix A to Subpart A of 10 CFR part 51, ''Format for Presentation of Material in Environmental Impact Statements.'' The environmental impacts of license renewal activities, including plant operations, maintenance, and

[4] ''Electromagnetic fields, chronic effects'' remains an uncategorized issue. Due to the lack of a scientific consensus on the impacts of chronic exposure to electromagnetic fields, the NRC has not categorized this issue and did not perform a plant-specific analysis. Once a scientific consensus is reached, the NRC will categorize the issue for license renewal.

refurbishment activities, along with replacement power alternatives, are addressed in each resource area. The revised GEIS evaluated environmental impact issues under the following resource areas: (1) Land use and visual resources, (2) air quality and noise, (3) geologic environment, (4) water resources (surface water resources and groundwater resources), (5) ecological resources (terrestrial resources, aquatic resources, special status species and habitats), (6) historic and cultural resources, (7) socioeconomics, (8) human health, (9) environmental justice, and (10) waste management and pollution prevention. The final rule revises Table B–1 to follow the organizational format of the revised GEIS.

In the 1996 GEIS, the NRC assumed that licensees would need to conduct major refurbishment activities to ensure the safe and economic operation of nuclear power plants beyond the current license term. Activities included replacement and repair of major components and systems, upgrades, and equipment. Replacement of many systems, structures, and components included steam generators and pressurizers for pressurized water reactors (PWRs) and recirculation piping systems for boiling water reactors (BWRs). It was assumed that many nuclear power plants would also undertake construction projects to replace or improve infrastructure. Such projects could include construction of new parking lots, roads, storage buildings, structures, and other facilities.

Licensee practice since publication of the 1996 GEIS has shown that many refurbishment activities have already taken place (e.g., steam generator and vessel head replacement). Most license renewal applicants have not identified any refurbishment activities associated with license renewal. Therefore, the revised GEIS assumes that impacts from refurbishment activities outside of license renewal have been accounted for in annual site evaluation reports, environmental operating reports, and radiological environmental monitoring program reports. Detailed analyses have not been performed for refurbishment actions in the revised GEIS. Instead, the impacts of typical activities during the license renewal term, including any refurbishment activities, are addressed for each resource area.

Environmental impacts of license renewal and the resources that could be affected are identified in the revised GEIS. The general analytical approach for identifying environmental impacts was to: (1) Describe the nuclear power plant activity that could result in an environmental impact, (2) identify the resource that may be affected, (3) evaluate past license renewal reviews and other available information, (4) assess the nature and magnitude of the environmental impact on the affected resource, (5) characterize the significance of the effects, and (6) determine whether the results of the analysis apply to all nuclear power plants (i.e., whether the impact issue is Category 1 or Category 2).

The revised GEIS, and therefore the final rule, retains the 1996 GEIS definitions of a Category 1 and Category 2 issue. While some Category 2 issues have been changed to Category 1, no Category 1 issue has been changed to Category 2. The final rule makes four major types of changes:

(1) *New Category 1 Issues:* New Category 1 issues are either new Category 1 issues (i.e., not previously evaluated in the 1996 GEIS and listed in Table B–1) or multiple Category 1 issues from the 1996 GEIS (and listed as multiple Category 1 issues in Table B–1 of the current rule) that have been consolidated into a single Category 1 issue in the revised GEIS and in Table B–1. An applicant for license renewal does not need to assess the potential environmental impacts from these issues in its environmental report. However, under 10 CFR 51.53(c)(3)(iv), the applicant is still responsible for reporting in the environmental report any ''new and significant information'' of which the applicant is aware. If the applicant is not aware of any new and significant information that changes the conclusion in the revised GEIS, the applicant must state this determination in the environmental report. The NRC has addressed the environmental impacts of these Category 1 issues generically for all plants in the revised GEIS.

(2) *New Category 2 Issues:* New Category 2 issues are either new Category 2 issues (i.e., not previously evaluated in the 1996 GEIS and listed in Table B–1) or multiple Category 2 issues from the 1996 GEIS (and listed as multiple Category 2 issues in Table B–1 of the current rule) that have been consolidated into a single Category 2 issue in the revised GEIS and in Table B–1. For each new Category 2 issue, an applicant must conduct a plant-specific assessment of the potential environmental impacts related to that issue and include it in its environmental report. The NRC will then analyze the potential environmental impacts related to that issue in the SEIS.

(3) *Existing Issue Category Changes from Category 2 to Category 1:* These are issues that were determined to be Category 2 in the 1996 GEIS and have been re-evaluated and determined to be Category 1 in the revised GEIS. Table B–1 has been amended by the final rule. An applicant is no longer required to conduct a plant-specific assessment of the environmental impacts associated with these issues in its environmental report. Similarly, the NRC is no longer required to analyze the potential environmental impacts related to that issue in the SEIS. However, consistent with the requirements of 10 CFR 51.53(c)(3)(iv), an applicant is still required to describe in its environmental report any ''new and significant information'' of which it is aware.

(4) Existing Issue Changes from Category 1 to Uncategorized: The ''Offsite radiological impacts of spent nuclear fuel and high-level waste disposal'' issue [5] was determined to be a Category 1 issue in the 1996 GEIS, but given the DC Circuit decision in *New York* v. *NRC,* the NRC reclassified the issue to uncategorized in the revised GEIS. Table B–1 has been amended by the final rule. Because the issue is uncategorized in this final rule, pending further action by the Commission, an applicant is not required to conduct a plant-specific assessment of the environmental impacts associated with this issue in its environmental report.

IV. Response to Public Comments

A. Overview

The public comment period for the proposed rule, draft revised GEIS, and draft guidance documents associated with this rulemaking, ended on January 12, 2010. The NRC received 32 document submissions containing comments from industry stakeholders, representatives of Federal and State agencies, and other interested parties. The NRC also received verbal comments at the six public meetings held during the public comment period. A detailed description of all public comments submitted on the proposed rule, draft revised GEIS, and draft guidance documents, and the NRC's responses to those comments, are contained in separate documents (*see* Section XII, ''Availability of Documents,'' of this document). The following section summarizes the major issues raised during the public comment period resulting in substantive changes to the rule and other issues raised for which no changes were made to the rule.

[5] The issue was named ''Offsite radiological impacts (spent fuel and high waste disposal)'' in the 1996 rule and GEIS.

B. Summary of Comments Resulting in Substantive Changes to the Rule

Several issues were raised during the public comment period that resulted in substantive changes to the proposed rule, which are briefly discussed in the following paragraphs.

Seismic issues. Many commenters wanted seismic issues to be included in the rule and pointed out the importance of reassessing seismic conditions in determining the safety of operating nuclear power plants. Industry commenters disagreed and argued that seismology should not be considered as part of the issue of ''Impacts of nuclear plants on geology and soils'' in the proposed rule because it is an ongoing safety issue that is being addressed at all plants.

NRC Response. The NRC agrees with the industry commenters that consideration of seismic conditions is an ongoing safety issue. Although seismic conditions at nuclear power plants were generically discussed in the revised GEIS as part of the geologic environment, seismology was not identified as a separate issue in the revised GEIS because the NRC considered historical earthquake data for each nuclear power plant when that plant was first licensed. The NRC requires all licensees to take seismic hazards into account in order to maintain safe operating conditions at all nuclear power plants. When new seismic hazard information becomes available, the NRC evaluates the new data and models to determine if any changes are needed at existing plants. This continuous oversight process, which includes seismic safety, remains separate from license renewal and takes place on an ongoing basis at all licensed nuclear facilities.

Sections 3.4 and 4.4.1 of the revised GEIS explain that geologic and seismic conditions were considered in the original design of nuclear power plants and are part of the license bases for operating plants. Seismic conditions are attributes of the geologic environment that are not affected by continued plant operations and refurbishment and are not expected to change appreciably during the license renewal term for all nuclear power plants. The findings relative to geologic and soil conditions were re-evaluated in the revised GEIS and as such, the issue has been renamed, ''Geology and soils,'' in Table B–1, and the findings have been revised for clarity.

Air quality impacts. Several commenters objected to the issue, ''Air quality (nonattainment and maintenance areas),'' being listed as a Category 2 issue in the proposed rule. These commenters argued that air quality impacts would be small even in worst-case situations, because licensees are required to operate within State air permit requirements.

NRC Response. The NRC agrees with the commenters. The final rule revises Table B–1 by reclassifying the issue as a Category 1 issue. Operating experience has shown that the potential impact from emergency generators and boilers on air quality would be small for all plants and, given the infrequency and short duration of maintenance testing, would not be an air quality concern even at plants located in or adjacent to nonattainment areas.

In addition, the analysis presented in the revised GEIS has shown that the worst-case emissions from cooling tower drift and particulate emissions at operating plants were also small. Air quality impacts from vehicle, equipment, and fugitive dust emissions associated with refurbishment would also be small for most plants but could be a cause for concern for plants located in or near air quality nonattainment or maintenance areas. However, the impacts are expected to be temporary and would cease once projects were completed. In addition, operating experience has shown that refurbishment activities have not required the large numbers of workers and extended durations conservatively predicted and analyzed in the 1996 GEIS, nor have such activities resulted in exceedances in the *de minimis* thresholds for criteria pollutants in nonattainment and maintenance areas. Consequently, the NRC agrees with these commenters' arguments that air quality impacts would be small for all plants and, therefore, a Category 1 issue.

Groundwater and soil contamination. Several commenters objected to the new Category 2 issue, ''Groundwater and soil contamination,'' in the proposed rule and asserted that contamination from industrial practices is addressed by the U.S. Environmental Protection Agency (EPA) and State regulations that monitor and address these impacts. Specifically, the use, storage, disposal, release, and/or cleanup of spilled or leaked solvents, hydrocarbons, and other potentially hazardous materials are governed by the Resource Conservation and Recovery Act (RCRA); Comprehensive Environmental Response, Compensation, and Liability Act; Toxic Substances Control Act; Federal Insecticide, Fungicide, and Rodenticide Act; and the Federal Water Pollution Control Act (also known as the Clean Water Act (CWA)).

NRC Response. While classified as a Category 2 issue in the proposed rule, further consideration of the ''Groundwater and soil contamination'' issue and public comments revealed that the potential impacts on groundwater and soil quality from common industrial practices (e.g., the use, handling, storage, and disposal of chemicals, petroleum products, waste, and hazardous material) can be addressed generically because industrial practices employed by nuclear power plants are not unique, but common to all industrial facilities. The NRC concludes that the overall impact of industrial practices on groundwater use and quality from past and current operations is small for all nuclear power plants and not expected to change appreciably during the license renewal term. The NRC agrees with the commenters to the extent that clarification was needed and that common industrial practices that can cause groundwater or soil contamination can be addressed generically as a Category 1 issue.

Further, the final rule combines the reclassified ''Groundwater and soil contamination'' issue with the Category 1 proposed rule issue, ''Groundwater use and quality,'' and renames the consolidated Category 1 issue as ''Groundwater contamination and use (non-cooling system impacts).'' These issues were consolidated because they both consider the impact of industrial activities associated with the continued operations of a nuclear power plant (not directly related to cooling system effects) on groundwater use and quality. Consolidating these issues also conforms to the resource-based approach used in the revised GEIS and serves to facilitate the license renewal environmental review process.

The finding column of Table B–1 for ''Impacts of refurbishment on groundwater use and quality'' prior to the final rule, as analyzed in the 1996 GEIS, indicated that impacts of continued operations and refurbishment on groundwater use and quality would be small, as extensive dewatering is not anticipated, and the application of best management practices for handling any materials produced or used during activities would reduce impacts. These findings were re-evaluated in the revised GEIS and are retained in the finding column of Table B–1 for the consolidated issue.

This new consolidated issue also considers the impacts on groundwater, soil, and subsoil from the industrial use of solvents, hydrocarbons, heavy metals, or other chemicals at nuclear power plant sites during the license renewal term, including the impacts resulting from the use of wastewater disposal ponds or lagoons (both lined or unlined). Industrial practices at all nuclear power plants have the potential to contaminate groundwater and soil, especially on sites with unlined wastewater and storm water lagoons. Contaminants have been found in groundwater and soil samples at some nuclear power plants during previous license renewal environmental reviews.

Any groundwater and soil contamination at operating nuclear power plants is subject to characterization and clean-up under EPA- and State-regulated remediation and monitoring programs. In addition, wastewater disposal ponds and lagoons are subject to discharge authorizations under the National Pollutant Discharge Elimination System (NPDES) and related State wastewater discharge permit programs. Each operating nuclear power plant must comply with these EPA and State regulatory requirements. As such, each site has an established program for handling chemicals, waste, and other hazardous materials. Moreover, nuclear power plant licensees are expected to employ best management practices, both in minimizing effluents and in remediation. Thus, this new consolidated issue, as set forth in the final revised GEIS and the final rule, is listed as a Category 1 issue.

C. Summary of Other Comments

Radionuclides in groundwater. Several commenters expressed opposition to the inclusion of a new Category 2 issue, ''Radionuclides released to groundwater,'' with an impact estimate of small to moderate in the proposed rule. Some commenters indicated that the issue category should be changed to Category 1; others suggested that the levels of significance should range to large. The argument for changing the issue to Category 1 was based on the voluntary industry-wide initiative, Nuclear Energy Institute (NEI) 07–07, ''Industry Ground Water Protection Initiative—Final Guidance Document'' (ADAMS Accession No. ML072610036), designed to protect groundwater.

NRC Response. This new, Category 2 issue evaluates the potential contamination and degradation of groundwater resources resulting from inadvertent discharges of radionuclides into groundwater from nuclear power plants. Within the past several years, there have been numerous events at power reactor sites that involved unknown, uncontrolled, and unmonitored releases of radionuclides into the groundwater. The number of these events and the high level of public controversy have made this an issue that the NRC believes needs a ''hard look,'' as required by NEPA.

As a voluntary action, NEI 07–07 cannot be enforced by the NRC. As such, no violations can be issued against a licensee who fails to comply with the guidance in NEI 07–07. Furthermore, the NRC cannot rely on a voluntary initiative as a basis to ensure that the nuclear power industry will monitor and have adequate information available for the NRC to determine whether the issue does or does not have an adverse impact on groundwater resources.

Regarding the magnitude of impact, the NRC bases its determination of small to moderate impact on a review of existing plants that have had inadvertent releases of radioactive liquids. Even though the NRC expects impacts for all plants to be within this range, a conclusion of large impact would not be precluded for a future license renewal review based on new and significant information, if the data supports such a conclusion. As reflected in the revised final GEIS and the final rule, ''Radionuclides released to groundwater,'' remains a Category 2 issue.

Radiation exposures to the public. Several commenters identified recent studies that claim an association between cancer risk and proximity to nuclear power facilities.

NRC Response. The NRC's regulatory limits for radiological protection are set to protect workers and the public from the harmful health effects (i.e., cancer and other biological impacts) of radiation to humans. The limits are based on the recommendations of scientific standards-setting organizations. These radiation standards reflect extensive scientific study by national and international organizations. The NRC actively participates in and monitors the work of these organizations to remain current on the latest trends in radiation protection. If the NRC determines that there is a need to revise its radiation protection regulations, it will initiate a separate rulemaking. The models recognized by the NRC for use by licensees to calculate dose incorporate conservative assumptions to ensure that workers and members of the public are adequately protected from radiation.

On April 7, 2010, the NRC announced that it asked the National Academy of Sciences (NAS) to perform a state-of-the-art study on cancer risk for populations surrounding nuclear power facilities (ADAMS Accession No. ML100970142). The NAS has a broad range of medical and scientific experts who can provide the best available analysis of the complex issues involved in discussing cancer risk and commercial nuclear power plants. The NAS is a nongovernmental organization chartered by the U.S. Congress to advise the nation on issues of science, technology, and medicine. Through the National Research Council and Institute of Medicine, it carries out studies independently of the Government, using processes designed to promote transparency, objectivity, and technical rigor. More information on its methods for performing studies is available at *http://www.nationalacademies.org/studycommitteprocess.pdf.*

The NAS study will update the 1990 U.S. National Institutes of Health National Cancer Institute (NCI) report, ''Cancer in Populations Living Near Nuclear Facilities'' (NCI 1990), which concluded there was no evidence that nuclear facilities may be linked causally with excess death from leukemia or from other cancers in populations living nearby.[6] The study's objectives are to: (1) Evaluate whether cancer risk is different for populations living near nuclear power facilities, (2) include cancer occurrence, (3) develop an approach to assess cancer risk in geographic areas that are smaller than the county level, and (4) evaluate the study results in the context of offsite doses from normal reactor operations. The study began in the summer of 2010 and is expected to be completed within 4 years. The final revised GEIS has added a discussion on the NRC's sponsorship of this follow-up to the 1990 NCI study.

Onsite storage of spent nuclear fuel, waste disposal, and Yucca Mountain. Several commenters expressed concern about the increasing volume of spent nuclear fuel at existing power plant sites and the availability of a geological repository at Yucca Mountain for future waste disposal.

NRC Response. The Commission is aware that geologic disposal, at Yucca Mountain or elsewhere, may not be available in the timeframe that was originally envisioned. As an alternative, the Commission has considered the storage of spent nuclear fuel on reactor sites where it is generated. The impacts associated with onsite storage of spent nuclear fuel at nuclear power plant sites during the license renewal term are discussed in Section 4.11.1.2 of the revised GEIS. The impacts associated with offsite radiological impacts from

[6] More information on this report is available at *http://www.cancer.gov/cancertopics/factsheet/Risk/nuclear-facilities.*

spent nuclear fuel and high-level waste disposal are discussed in Section 4.11.1.3 of the revised GEIS. In light of the DC Circuit's decision in *New York* v. *NRC,* 681 F.3d 471, the NRC has revised two Table B–1 issues, ''Onsite storage of spent nuclear fuel'' and ''Offsite radiological impacts of spent nuclear fuel and high-level waste disposal.'' Section V of this document, ''Related Issues of Importance,'' provides a discussion of the NRC's revisions to these two issues, as well as the actions the NRC has taken or will take in response to the *New York* v. *NRC* decision.

Postulated accidents. Numerous comments were received on the NRC's evaluation and classification of postulated accidents in the draft revised GEIS. One commenter disagreed with the GEIS' conclusion that environmental impact from design basis accidents (DBAs) is small. Also, several commenters disagreed with the GEIS conclusion that the environmental impact from severe accidents is small and further, that the evaluation is not adequate because of its use of probability-weighted risk assessments. Their position is that for severe accidents, the revised GEIS should also evaluate the consequences of reactor accidents and expand the evaluation to include spent fuel pool accidents and accidents due to age-related plant component degradation. In addition, some of the commenters stated that the NRC has gained enough information from the many plant licenses it has renewed to make a determination, on a generic basis, that the ''severe accidents'' issue should be reclassified as Category 1.

NRC Response.

Design Basis Accidents. The NRC does not agree that the GEIS' evaluation of DBAs is incorrect. The NRC evaluates and presents the potential consequences of DBAs in nuclear power plant licensing documents and considers them in the GEIS for license renewal.

In order to receive NRC approval for an initial operating license, an applicant must submit a final safety analysis report (FSAR) as part of its application. The FSAR presents the applicable design criteria and design information for the proposed reactor, as well as comprehensive data on the proposed site. The FSAR also discusses hypothetical reactor accident situations and addresses the safety features that prevent and mitigate those accidents. During the initial licensing process for a power reactor, the NRC reviews the FSAR to determine whether or not the plant design meets the NRC's regulations.

At initial licensing, the NRC also considered the environmental impact of DBAs at each operating nuclear power plant. The DBAs are those events that both the applicant and the NRC evaluate to ensure that the plant can withstand normal and abnormal transients (e.g., rapid changes in reactor power) without undue risk to the health and safety of the public. Although the NRC does not expect that all of these postulated events will occur during the life of the plant, the NRC evaluates them to establish the basis for the preventive and mitigative safety systems of the facility. The acceptance criteria for DBAs are described in 10 CFR part 50, ''Domestic Licensing of Production and Utilization Facilities,'' and 10 CFR part 100, ''Reactor Site Criteria.'' Compliance with these regulations provides reasonable assurance of adequate protection of public health and safety.

During operations, the NRC requires each power plant licensee to maintain acceptable design and performance criteria in accordance with the NRC's regulations, including during any license renewal period. Therefore, the calculated releases from DBAs will remain within the NRC's regulatory limits.

The 1996 GEIS, in Section 5.2, discusses the impacts of potential accidents. It contains a discussion of plant accidents and consequences. This discussion addresses general characteristics of design basis (and severe) accidents, characteristics of fission products, meteorological considerations, possible exposure pathways, potential adverse health effects, avoiding adverse health effects, accident experience and observed impacts, and emergency preparedness. The revised GEIS reexamined the information from the 1996 GEIS and concluded that it is still valid. Because the information on DBAs is valid and has not changed, the revised GEIS does not repeat the information from the 1996 GEIS.

Severe Accidents. The NRC does not agree with the comments that the revised GEIS evaluation is inadequate regarding the impacts from severe accidents because it uses probability-weighted risk assessments. Severe accidents (i.e., beyond design basis accidents) are those that could result in substantial damage to the reactor core, whether or not there are serious off-site consequences. The 1996 GEIS estimated and considered the potential impacts on human health and economic factors from full-power severe reactor accidents initiated by internal events at different types of nuclear facilities located in different types of settings. That evaluation included modeling the release of radioactive materials into the environment and modeling the pathways (i.e., exposure to the radioactive plume, inhalation of radioactivity, consumption of contaminated food) through which members of the public could potentially be exposed to doses of radiation. Based on the calculated doses, the GEIS reported the consequences (i.e., potential early and latent fatalities) from such accidents. In developing a potential impact level, however, the NRC took into account the very low probability of such events, as well as their potential consequences, and concluded that the likely impact from individual nuclear power plants is small.

In the revised GEIS, the NRC expanded the scope of the severe accident evaluations and used more recent technical information that included both internal and external event core-damage frequency, as well as improved severe accident source terms, spent fuel pool accidents, low power and reactor shutdown events, new radiation risk-coefficients from the National Academy of Sciences, ''Health Risks from Exposure to Low Levels of Ionizing Radiation: Biological Effects of Ionizing Radiation (BEIR) VII'' report,[7] and risk impacts of reactor power uprates and higher fuel burn-up levels. As a result, the revised GEIS considers updated information in determining the potential consequences of a reactor accident. Considering this updated information and that severe reactor accidents remain unlikely, the revised GEIS concludes that the environmental impacts of a severe accident remain small.

The NRC notes, however, that the GEIS is not the primary vehicle the NRC uses to address and regulate risks from severe accidents. The NRC's regulations and regulatory practices employ safety standards in the design, construction, and operation of nuclear power plants as well as risk models to ensure the public is adequately protected on an ongoing basis. The NRC's ongoing oversight addresses the public's risk from nuclear power plant accidents, accounts for the effects of proposed changes that may be made as part of power plant operations, and considers new information about the facility or its environment when necessary.

[7] The BEIR VII report can be accessed at *http://search.nap.edu/napsearch.php?term=beir+vii.* The NRC staff reviewed this report in SECY–05–0202, ''Staff Review of the National Academies Study of the Health Risks from Exposure to Low Levels of Ionizing Radiation (BEIR VII),'' dated October 29, 2005 (ADAMS Accession No. ML052640532).

Although the NRC has determined that impacts from severe accidents are small for all facilities, the NRC continues to maintain that severe accidents cannot be a Category 1 issue because plant-specific mitigation measures vary greatly based on plant designs, safety systems, fuel type, operating procedures, local environment, population, and siting characteristics. Thus, severe accidents remain a Category 2 issue. Accordingly, the NRC has not changed the requirements in 10 CFR 51.53(c)(3)(ii)(L) that an applicant's environmental report must contain a discussion that considers alternatives to mitigate severe accidents if the NRC has not previously considered this issue in an environmental impact statement or environmental assessment for the facility.

Spent Fuel Pool Accidents. The 1996 GEIS included a quantitative analysis of a severe accident involving a reactor operating at full power. A qualitative evaluation of SFP accidents is presented in Appendix E of the revised GEIS. Based on this evaluation, the revised GEIS concludes that the environmental impacts from accidents involving SFPs are comparable to those from the reactor accidents at full power that were evaluated in the 1996 GEIS and as such, SFP accidents do not warrant separate evaluation. Based on the continued validity of conclusions from the 1996 GEIS, as affirmed by the Commission (*see* following paragraph), the revised GEIS does not contain a quantitative evaluation of SFP accidents.

The issue of an accident involving the spent fuel pool was specifically addressed by the NRC in its denial of two petitions for rulemaking (PRM): PRM–51–10 and PRM–51–12, submitted by the Attorney General of the Commonwealth of Massachusetts in 2006 and the Attorney General of California in 2007, respectively.[8] The petitioners requested that the NRC initiate a rulemaking concerning the environmental impacts of the high density storage of spent nuclear fuel in SFPs. The petitioners asserted that ''new and significant information'' shows that the NRC incorrectly characterized the environmental impacts of high-density spent fuel storage as ''insignificant'' in the 1996 GEIS for the renewal of nuclear power plant licenses. Specifically, the petitioners asserted that spent fuel stored in high-density SFPs is more vulnerable to a zirconium fire than the NRC concluded in its NEPA analysis. The NRC denied the two petitions, and the NRC denial was upheld by the United States Court of Appeals.

Aging-related Degradation. Issues related to age-related plant component degradation are addressed in the NRC's safety evaluation of the plant's license renewal application. The regulations covering the safety review for license renewal are in 10 CFR part 54, ''Requirements for Renewal of Operating Licenses for Nuclear Power Plants.''

The 1996 GEIS discusses the potential effects of age on the physical plant and notes that such deterioration could result in an increased likelihood of component or structure failure that could increase the rate of plant accidents. The GEIS notes that the NRC requires an applicant for license renewal to address the issue of age-related degradation by identifying, in an integrated plant assessment process, those passive, long-lived structures and components that are susceptible to age-related degradation and whose functions are necessary to ensure that the facility's current licensing basis is maintained. The GEIS found that the safety evaluation performed by the NRC as part of the license renewal process provides reasonable assurance that age-related degradation is managed and adequate protection of the health and safety of the public is maintained during the license renewal period. Therefore, the 1996 GEIS concluded, ''. . . the probability of any radioactive releases from accidents will not increase over the license renewal period.'' Based on nuclear power plants' continued compliance with 10 CFR part 54 to manage age-related degradation, the revised GEIS did not alter or revise this conclusion from the 1996 GEIS.

Greenhouse gas emissions and climate change. Several commenters discussed the need to include a discussion of the effects of climate change on plant operations and the effect of continued operations during the license renewal period on environmental resources affected by climate change.

NRC Response. The NRC acknowledges these concerns. The NRC has begun to evaluate the effects of greenhouse gas (GHG) emissions and its implications for global climate change in its environmental reviews for both new reactor and license renewal applications. Changes in climate have the potential to affect air and water resources, ecological resources, and human health, and should be taken into account when evaluating cumulative impacts over the license renewal term.

Subsequent to the publication of the proposed rule and during the public comment period, the Commission issued a memorandum and order concerning two combined operating license applications for new reactor units at the Tennessee Valley Authority Bellefonte site in Alabama and the Duke Energy Carolinas Lee site in South Carolina (CLI–09–21). The memorandum and order stated:

> because the Staff is currently addressing the emerging issues surrounding greenhouse gas emissions in environmental reviews required for the licensing of nuclear facilities, we believe it is prudent to provide the following guidance to the Staff. We expect the Staff to include consideration of carbon dioxide and other greenhouse gas emissions in its environmental reviews for major licensing actions under the National Environmental Policy Act. The Staff's analysis for reactor applications should encompass emissions from the uranium fuel cycle as well as from construction and operation of the facility to be licensed. The Staff should ensure that these issues are addressed consistently in agency NEPA evaluations and, as appropriate, update Staff guidance documents to address greenhouse gas emissions.[9]

Presently, insufficient data exists to support an impact level on a generic basis. The NRC only has direct emission data for a handful of facilities. Although some states have varying reporting requirements, GHG emissions reporting nationwide is in its infancy. The EPA promulgated its GHG emissions reporting rule on October 30, 2009 (74 FR 56260). In accordance with this rule, the first industry reporting date was March 31, 2011.[10] Moreover, the 25,000 annual metric ton reporting threshold EPA established in the final rule of October 30, 2009, is not an indication of what EPA considers to be a significant (or insignificant) level of GHG emissions on a scientific basis, but a threshold chosen by EPA for policy evaluation purposes.[11]

In order to comply with the Commission's direction in CLI–09–21 and in response to the comments received, a new section, ''Greenhouse Gas Emissions and Climate Change'' (Chapter 4, Section 4.12.3), summarizing the potential cumulative

[8] These PRMs were denied in the same **Federal Register** notice (73 FR 46204; August 8, 2008).

[9] In the matter of Duke Energy Carolinas, LLC (Combined License Application for William States Lee III Nuclear Station, Units 1 and 2); In the matter of Tennessee Valley Authority (Bellefonte Nuclear Power Plant, Units 3 and 4), CLI–09–21 (NRC November 3, 2009).

[10] 74 FR at 56267: October 30, 2009, codified at 40 CFR 98.3(b) (''The annual GHG report must be submitted no later than March 31 of each calendar year for GHG emissions in the previous calendar year'').

[11] The EPA concluded for policy evaluation purposes, that the 25,000 metric ton threshold more effectively targets large industrial emitters and suppliers, covers approximately 85 percent of the U.S. emissions, and minimizes the burden on smaller facilities (74 FR 56264; October 30, 2009).

impacts of GHG emissions and global climate change, has been added to the final revised GEIS. The NRC will also include within each SEIS a plant-specific analysis of any impacts caused by GHG emissions over the course of the license renewal term as well as any impacts caused by potential climate change upon the affected resources during the license renewal term. The final rule was not revised to include any reference to GHG emissions or climate change.

Recent advances in alternative energy technologies. Several commenters asserted that much of the information describing alternative energy technologies did not reflect the state-of-the-science. In some cases, commenters noted facts and events that occurred after the publication date of the draft revised GEIS.

NRC Response. The NRC has updated the final revised GEIS to incorporate the latest information on replacement power alternatives, but it is inevitable that rapidly evolving technologies will outpace the information presented in the final revised GEIS. Incorporation of this information is more appropriately made in the context of plant-specific license renewal reviews, rather than in the evaluations contained in the revised GEIS. As with renewable energy technologies, energy policies are evolving rapidly. While the NRC acknowledges that legislation, technological advancements, and public policy can underlie a fundamental paradigm shift in energy portfolios, the NRC cannot make decisions based on anticipated or speculative changes. Instead, the NRC considers the status of replacement power alternatives and energy policies when conducting plant-specific reviews. The final revised GEIS has been updated to clarify the NRC's approach to conducting replacement power alternative evaluations.

Emergency preparedness and security. Several commenters expressed concern with emergency preparedness, evacuation, and safety and security at nuclear power plants. Commenters stated that these topics were not addressed in the proposed rule and not adequately covered in the revised GEIS and should be included in the scope of the plant-specific SEISs.

NRC Response. Emergency preparedness and planning are part of the current licensing basis for each holder of a 10 CFR part 50 operating license and are outside the regulatory scope of license renewal. Before a plant is licensed to operate, the NRC must have ''reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency'' (10 CFR 50.47). The Commission's regulatory scheme provides continuing assurance that emergency planning for every operating nuclear power plant is adequate. The Commission has determined that there is no need for a special review of emergency planning issues in the context of an environmental review for license renewal because the ongoing decisions and findings concerning emergency preparedness at nuclear power plants address concerns as they arise.

The Commission considered the need for a review of emergency planning issues in the context of license renewal during its rulemaking proceedings on 10 CFR part 54, which included public notice and comment. As discussed in the Statement of Considerations for the 10 CFR part 54 rulemaking (56 FR 64966; December 13, 1991), the programs for emergency preparedness at nuclear power facilities apply to all nuclear power facility licensees and require the specified levels of protection from each licensee regardless of plant design, construction, or license date. The NRC requirements related to emergency planning are in the regulations at 10 CFR 50.47 and Appendix E to 10 CFR part 50, ''Emergency Planning and Preparedness for Production and Utilization Facilities.'' These requirements apply to all holders of operating licenses and will continue to apply to facilities with renewed licenses. Through its standards and required exercises, the Commission reviews existing emergency preparedness plans throughout the life of any facility, keeping up with changing demographics and other site-related factors.

Further, the NRC actively reviews its regulatory framework to ensure that the regulations are current and effective. The agency began a major review of its emergency preparedness framework in 2005, including a comprehensive review of the emergency preparedness regulations and guidance, the issuance of generic communications regarding the integration of emergency preparedness and security, and outreach efforts to interested persons to discuss emergency preparedness issues. These activities informed a rulemaking effort to enhance the NRC's emergency preparedness regulations and guidance. This effort culminated in a final rule, which was published in the **Federal Register** on November 23, 2011 (76 FR 72560).

Security issues are not tied to a license renewal action but are treated on an ongoing basis as a part of the current (and renewed) operating license. If issues related to security are discovered at a nuclear power plant, they are addressed immediately, and any necessary changes are reviewed and incorporated under the current operating license. For example, after the terrorist attacks of September 11, 2001, the NRC issued security-related orders and guidance to nuclear power plant licensees. These orders and guidance included interim measures for emergency planning. Nuclear industry groups and Federal, State, and local government agencies assisted in the prompt implementation of these measures and participated in drills and exercises to test these new planning elements. The NRC reviewed licensees' commitments to address these requirements and verified their implementation through inspections to ensure public health and safety.

In summary, the issue of security is not unique to nuclear power plants requesting license renewal. The NRC routinely assesses threats and other information provided by other Federal agencies and sources. The NRC also ensures that licensees meet their security requirements through its ongoing regulatory process (routine inspections) as a current and generic regulatory issue that affects all nuclear power plants. Therefore, as discussed in the Statement of Considerations for the 10 CFR part 54 rulemaking (56 FR 64966), the Commission determined that there is no need for an evaluation of security issues in the context of a license renewal review.

V. Related Issues of Importance

This section addresses five issues of related importance to the final rule: (1) Consideration of the recent events at the Fukushima Dai-ichi Nuclear Power Plant, (2) removal of those parts of the final rule that refer to and rely upon the NRC's Waste Confidence Decision and Rule, (3) a description of the final rule's effective and compliance dates, (4) clarification of the term ''best management practices,'' and (5) deletion of the proposed definition of the term ''historic properties.''

A. Fukushima Events

On March 11, 2011, a massive earthquake off the east coast of Honshu, Japan produced a devastating tsunami that struck the coastal town of Fukushima. The six-unit Fukushima Dai-ichi Nuclear Power Plant was directly impacted by these events. The resulting damage caused the failure of several of the units' safety systems needed to maintain cooling water flow to the reactors. As a result of the loss of cooling, the fuel overheated, and there was a partial meltdown of the fuel contained in several of the reactors. Damage to the systems and structures containing reactor fuel resulted in the release of radioactive material to the surrounding environment.

In response to the earthquake, tsunami, and resulting reactor accidents at the Fukushima Dai-ichi Nuclear Power Plant (hereafter referred to as the ''Fukushima events''), the Commission directed the NRC staff to convene an agency task force of senior leaders and experts to conduct a methodical and systematic review of the relevant NRC regulatory requirements, programs, and processes, including their implementation, and to recommend whether the agency should make near-term improvements to its regulatory system. As part of the short-term review, the task force concluded that, while improvements are expected to be made as a result of the lessons learned from the Fukushima events, the continued operation of nuclear power plants and licensing activities for new plants do not pose an imminent risk to public health and safety.[12]

During the time that the task force was conducting its review, groups of individuals and non-governmental organizations petitioned the Commission to suspend all licensing decisions in order to conduct a separate, generic NEPA analysis to determine whether the Fukushima events constituted ''new and significant information'' under NEPA that must be analyzed as part of environmental reviews. The Commission found the request premature and noted, ''[i]n short, we do not know today the full implications of the [Fukushima] events for U.S. facilities.'' [13] However, the Commission found that if ''new and significant information comes to light that requires consideration as part of the ongoing preparation of application-specific NEPA documents, the agency will assess the significance of that information, as appropriate.'' [14] The Federal courts of appeal and the Commission have interpreted NEPA such that an EIS must be updated to include new information only when that new information provides ''a seriously different picture of the environmental impact of the proposed project from what was previously envisioned.'' [15]

In the context of the revised GEIS and this rulemaking, the Fukushima events are considered a severe accident (i.e., a type of accident that may challenge a plant's safety systems at a level much higher than expected) and more specifically, a severe accident initiated by an event external to the plant. The 1996 GEIS concluded that risks from severe accidents initiated by external events (such as an earthquake) could have potentially high consequences but found that external events are adequately addressed through a consideration of a severe accident initiated by an internal event (such as a loss of cooling water). Therefore, an applicant for license renewal need only analyze the environmental impacts from an internal event in order to adequately characterize the environmental impacts from either type of event. The revised GEIS examined more recent and up-to-date information regarding external events and concluded that the analysis in the 1996 GEIS remains valid. The Fukushima events are not considered in the revised GEIS because the analysis in the revised GEIS was completed prior to the Fukushima events.

The NRC's evaluation of the consequences of the Fukushima events is ongoing. As such, the NRC will continue to evaluate the need to make improvements to existing regulatory requirements based on the task force report and additional studies and analyses of the Fukushima events as more information is learned. To the extent that any revisions are made to the NRC's regulatory requirements, they would be made applicable to nuclear power reactors regardless of whether or not they have a renewed license. Therefore, no additional analyses have been performed in the revised GEIS as a result of the Fukushima events. In the event that the NRC identifies information from the Fukushima events that constitutes new and significant information with respect to the environmental impacts of license renewal, the NRC will discuss that information in its site-specific SEISs to the GEIS, as it does with all such new and significant information.

B. Removal of References to the Waste Confidence Decision and Rule

The Waste Confidence Decision and Rule represented the Commission's generic determination that spent nuclear fuel can continue to be stored safely and without significant environmental impacts for a period of time after the end of the licensed life for operation of a nuclear power plant.[16] This generic determination meant that the NRC did not need to consider the storage of spent nuclear fuel after the end of a reactor's licensed life for operation in the NEPA documents that support its reactor and spent-fuel storage license application reviews.

On December 23, 2010, the Commission published a revision of the Waste Confidence Decision and Rule to reflect information gained from experience in the storage of spent nuclear fuel and the increased uncertainty in the siting and construction of a permanent geologic repository for the disposal of spent nuclear fuel and high-level waste.[17] In response to the 2010 Waste Confidence Decision and Rule, the states of New York, New Jersey, Connecticut, and Vermont, along with several other parties, challenged the Commission's NEPA analysis in the decision, which provided the regulatory basis for the rule. On June 8, 2012, the United States Court of Appeals, District of Columbia Circuit, in *New York* v. *NRC,* 681 F.3d 471 (D.C. Cir. 2012), vacated the NRC's Waste Confidence Decision and Rule, after finding that it did not comply with NEPA.

The court concluded that the Waste Confidence Decision and Rule is a major federal action necessitating either an EIS or an environmental assessment that results in a ''finding of no significant impact.'' In vacating the 2010 decision and rule, the court identified three specific deficiencies in the analysis:

1. As to the Commission's conclusion that permanent disposal will be available ''when necessary,'' the court held that the Commission did not evaluate the environmental effects of failing to secure permanent disposal;

2. As to the storage of spent fuel on-site at nuclear plants after the expiration

[12] Recommendations for Enhancing Reactor Safety in the 21st Century, The Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident'' (July 12, 2011) (ADAMS Accession No. ML111861807).

[13] *Union Electric Co. d/b/a Ameren Missouri* (Callaway Plant, Unit 2), CLI–11–05, _ NRC _, _ (slip op. at 30) (Sept. 9, 2011).

[14] *Id.* at 30–31.

[15] *Id.* at 31 (quoting *Hydro Resources, Inc.* (2929 Coors Road, Suite 101, Albuquerque, NM 87120), CLI–99–22, 50 NRC 3, 14 (1999) (citing *Marsh* v. *Oregon Natural Resources Council,* 490 U.S. 360, 373 (1989))). The Commission also noted that it can modify a facility's operating license outside of a renewal proceeding and made clear that ''it will use the information from these activities to impose any requirement it deems necessary, irrespective of whether a plant is applying for or has been granted a renewed operating license.'' *Id.* at 26–27.

[16] The NRC first adopted the Waste Confidence Decision and Rule in 1984. The NRC amended the decision and rule in 1990, reviewed them in 1999, and amended them again in 2010. 49 FR 34694 (August 31, 1984); 55 FR 38474 (September 18, 1990); 64 FR 68005 (December 6, 1999); and 75 FR 81032 and 81037 (December 23, 2010). The NRC made a minor amendment to the rule in 2007 to clarify that it applies to combined licenses. 72 FR 49509 (August 28, 2007). The Waste Confidence Decision and Rule are codified in the NRC regulation 10 CFR 51.23.

[17] 75 FR 81032 and 81037.

of a plant's operating license, the court concluded that the Commission failed to properly examine the risk of spent fuel pool leaks in a forward-looking fashion; and

3. Also related to the post-license storage of spent fuel, the court concluded that the Commission failed to properly examine the consequences of spent fuel pool fires.

In response to the court's ruling, the Commission issued CLI–12–16 on August 7, 2012 (ADAMS Accession No. ML12220A212), in which the Commission determined that it would not issue licenses that rely upon the Waste Confidence Decision and Rule until the issues identified in the court's decision are appropriately addressed by the Commission. CLI–12–16 provided, however, that the decision not to issue licenses only applied to final license issuance; all licensing reviews and proceedings should continue to move forward. In SRM–COMSECY–12–0016, ''Approach for Addressing Policy Issues Resulting from Court Decision to Vacate Waste Confidence Decision and Rule,'' dated September 6, 2012 (ADAMS Accession No. 12250A032), the Commission directed the NRC staff to proceed with a rulemaking that includes the development of a generic EIS to support a revised Waste Confidence Decision and Rule and to publish both the EIS and the revised decision and rule in the **Federal Register** within 24 months. The Commission indicated that both the EIS and the revised Waste Confidence Decision and Rule should build on the information already documented in various NRC studies and reports, including the existing environmental assessment that the NRC developed as part of the 2010 Waste Confidence Decision and Rule. The Commission directed that any additional analyses should focus on the three deficiencies identified in the court's decision. The Commission also directed that the NRC staff provide ample opportunity for public comment on both the draft EIS and the proposed Waste Confidence Decision and Rule.

In accordance with CLI–12–16, the NRC will not approve any site-specific license renewal applications until the deficiencies identified in the court's decision have been resolved. Two Table B–1 license renewal issues that rely, wholly or in part, upon the Waste Confidence Decision and Rule are the ''Onsite storage of spent nuclear fuel'' and ''Offsite radiological impacts of spent nuclear fuel and high-level waste disposal.'' Both of these issues were classified as Category 1 in the 10 CFR part 51 rule that was promulgated in 1996; the 2009 proposed rule continued the Category 1 classification for both of these issues. As part of the NRC's response to the *New York* v. *NRC* decision, this final rule revises these two issues accordingly. Specifically, this final rule revises the Category 1 ''Onsite storage of spent nuclear fuel'' issue to narrow the period of onsite storage to the license renewal term. In both the 1996 rule [18] and the 2009 proposed rule, the NRC relied upon the Waste Confidence Decision and Rule to make a generic finding that spent nuclear fuel could be stored safely onsite with no more than a small environmental impact for the term of the extended license (from approval of the license renewal application to the expiration of the operating license) plus a 30-year period following the permanent shutdown of the power reactor and expiration of the operating license.[19]

The Waste Confidence Decision and Rule provided the basis for the 30-year period following the permanent shutdown of the reactor and expiration of the operating license. The 2010 Waste Confidence Decision and Rule extended this post-reactor shutdown onsite storage period from 30 years to 60 years. Given the *New York* v. *NRC* decision, and pending the issuance of a generic EIS and revised Waste Confidence Decision and Rule (as directed by SRM–COMSECY–12–0016), the final rule excludes from this issue the period of onsite storage of spent nuclear fuel following the permanent shutdown of the power reactor and expiration of the operating license. As revised by this final rule, this issue now covers the onsite storage of spent fuel for the term of the extended license only.

Similarly, this final rule revises the Category 1 issue ''Offsite radiological impacts of spent nuclear fuel and high level waste disposal.'' [20] In both the 1996 rule and the 2009 proposed rule, this issue pertained to the long-term disposal of spent nuclear fuel and high-level waste, including possible disposal in a deep geologic repository. Although the Waste Confidence Decision and Rule did not assess the impacts associated with disposal of spent nuclear fuel and high-level waste in a repository, it did reflect the Commission's confidence, at the time, in the technical feasibility of a repository and when that repository could have been expected to become available. Without the analysis in the Waste Confidence Decision, the NRC cannot assess how long the spent fuel will need to be stored onsite. Therefore, the final rule reclassifies this issue from a Category 1 issue with no assigned impact level to an uncategorized issue with an impact level of uncertain.

Upon issuance of the generic EIS and revised Waste Confidence Rule, the NRC will make any necessary conforming amendments to this rule. As referenced previously, the Commission will not approve any license renewal application for an operating nuclear power plant until the issues identified in the court's decision are appropriately addressed by the Commission.

C. Effective and Compliance Dates for Final Rule

The amendments made by the final rule shall be effective 30 days after the final rule's publication in the **Federal Register**. License renewal applicants are not required to comply with the amended rule until 1 year after the final rule's publication in the **Federal Register**. The Commission has decided on a 1-year compliance date given the long lead time required for preparation of license renewal applicant environmental reports.

D. Best Management Practices

''Best management practices'' is a term used to describe a type, method, or treatment technique for preventing pollution or reducing the quantities of pollutants released to the environment. The term, as used herein, includes the physical components used to control or minimize pollution (e.g., filters, barriers, mechanical devices, and retention ponds), as well as operational or procedural practices (e.g., minimizing use of a pollutant, spill control, and operator training). Best management practices are used in a variety of industrial sectors. In the nuclear power reactor sector, as in other industrial sectors, best management practices offer flexibility to achieve a balance between protecting the environment and the efficiency and economic limitations associated with the operations of a given plant. Both in the 1996 GEIS and in the revised GEIS, several issues have been determined to be a Category 1 issue with an impact level of small based upon the assumption that the license renewal applicant employs and will continue to employ best management practices

[18] The issue was named ''On-site spent fuel'' in the 1996 rule.

[19] Prior to the December 23, 2010, final rule, 10 CFR 51.23(a) read: ''The Commission has made a generic determination that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of that reactor at its spent fuel storage basin or at either onsite or offsite independent spent fuel storage installations.''

[20] The issue was named ''Offsite radiological impacts (spent fuel and high level waste disposal)'' in the 1996 rule.

during the license renewal term. The NRC's regulatory experience has shown that licensees employ such best management practices.

The NRC's jurisdiction is limited to radiological health and safety and common defense and security. Therefore, the NRC does not generally impose a requirement that its licensees adopt those best management practices that concern non-radiological pollutants. The NRC nuclear power plant licensees, however, are subject to a host of regulatory requirements that are monitored and enforced by other Federal agencies (e.g., the EPA) or State or local regulatory agencies. The NRC-licensed nuclear power plants must obtain a variety of permits from these other agencies before they can operate (e.g., under the CWA, a licensee must obtain a NPDES permit from the EPA or, if the EPA has delegated its CWA authority to a particular State, from the appropriate agency of that State). These permits typically require that the licensee adopt and adhere to best management practices.

Therefore, an assumption underlying the revised GEIS is that NRC licensees will use best management practices to comply with other Federal, State, and local government requirements to prevent or reduce the quantities of non-radiological pollutants released to the environment. This description of best management practices is not a regulatory or policy change by the NRC because the use of best management practices by nuclear power plant licensees was also an underlying assumption of the 1996 GEIS. Rather, the NRC seeks to make transparent its basis for determining that certain issues are Category 1 issues with a small level of impact.

E. Definition of ''Historic Properties''

The proposed rule would have amended 10 CFR part 51 by adding a definition of the term ''historic properties'' to 10 CFR 51.14(a). Upon further consideration, the NRC determined that adding the definition was unnecessary. The NRC's license renewal determination to renew or not renew a nuclear power plant operating license is considered an undertaking as defined by Section 106 of the National Historic Preservation Act (NHPA) and its implementing regulations in 36 CFR part 800. The regulations define the term ''historic property'' in 36 CFR 800.16(l)(1). The NRC uses the term ''historic property'' or ''historic properties'' in the same context as set forth in 36 CFR 800.16(l)(1).

VI. Revisions to 10 CFR 51.53

The final rule revises 10 CFR 51.53 to conform to those changes made by the final rule to Table B–1. Because some Category 2 issues have been reclassified as Category 1 issues, license renewal applicants no longer need to assess these issues and, therefore, the final rule removes the requirements for applicants to provide information on these issues in their environmental reports. The final rule also adds new requirements to 10 CFR 51.53 for the new Category 2 issues for which applicants are now required to provide information in their environmental reports. The following describes each revision.

A. Reclassifying Category 2 Issues as Category 1 Issues

Section 51.53(c)(3)(ii)(F). The final rule removes and reserves 10 CFR 51.53(c)(3)(ii)(F) because the final rule reclassifies the Category 2 issue, ''Air quality during refurbishment (nonattainment and maintenance areas),'' to Category 1 and renames the issue, ''Air quality impacts (all plants).'' The removed regulatory language required the applicant to assess anticipated vehicle exhaust emissions at the time of refurbishment for plants located in or near a nonattainment or maintenance area, as those terms are defined under the Clean Air Act.

The final rule reclassifies this issue as Category 1 based upon public comments received on the proposed rule [21] and a subsequent re-evaluation of the data in the draft revised GEIS, which showed that air quality impacts from refurbishment have not resulted in exceedances in the *de minimis* thresholds for criteria pollutants in nonattainment and maintenance areas due to construction vehicle, equipment, and fugitive dust emissions. Significant air quality impacts are no longer anticipated from future license renewals. Therefore, applicants no longer need to assess the impacts on air quality of continued operations and refurbishment associated with license renewal in their environmental reports.

Section IV, ''Response to Public Comments,'' of this document provides a summary of the comments received on this issue, and Section VIII, ''Final Actions and Basis for Changes to Table B–1,'' of this document discusses this issue in more detail under Issue 5, ''Air quality impacts (all plants).''

Section 51.53(c)(3)(ii)(I). The final rule removes and reserves 10 CFR 51.53(c)(3)(ii)(I) because several Category 2 socioeconomic issues are reclassified as Category 1. The removed regulatory language required the applicant to assess the impacts of the proposed license renewal on housing availability, land use, and public schools (impacts from refurbishment activities only) within the vicinity of the plant. Additionally, the removed regulatory language required the applicant to assess the impact of population increases attributable to the proposed project on the public water supply. Specifically, the final rule reclassifies the following 1996 GEIS Category 2 socioeconomic issues: Housing impacts; [22] Public services: public utilities; [23] Public services, education (refurbishment); [24] Offsite land use (refurbishment); and Offsite land use (license renewal term).[25]

The final rule reclassifies these issues as Category 1 because significant changes in housing availability, land use, and increased population demand attributable to the proposed refurbishment project on the public water supply have not occurred at relicensed nuclear power plants. Therefore, impacts to these resources are no longer anticipated for future license renewals. In addition, refurbishment activities (such as steam generator and vessel head replacement) have not required the large numbers of workers and the months of time that were conservatively analyzed in the 1996 GEIS. As such, significant impacts on housing availability, land use, public schools, and the public water supply are no longer anticipated from continued operations during the license renewal term and refurbishment associated with license renewal.

Section 51.53(c)(3)(ii)(J). The final rule removes and reserves 10 CFR 51.53(c)(3)(ii)(J) because the Category 2 issue, ''Public services, transportation,'' is reclassified as Category 1 (the final rule also renames the issue, ''Transportation''). The removed

[21] The proposed rule renamed the ''Air quality during refurbishment (nonattainment and maintenance areas)'' issue as ''Air quality (nonattainment and maintenance areas)'' and retained the Category 2 classification.

[22] The final rule renames this issue as ''Population and housing'' (*see* Issue (55) under Section VIII, ''Final Actions and Basis for Changes to Table B–1,'' of this document).

[23] The final rule merges this issue into the consolidated issue, ''Community services and education'' (*see* Issue (54) under Section VIII of this document).

[24] The final rule merges this issue into the consolidated issue, ''Community services and education'' (*see* Issue (54) under Section VIII of this document).

[25] The final rule merges ''Offsite land use (refurbishment)'' and ''Offsite land use (license renewal term) into the consolidated issue, ''Offsite land use'' (*see* Issue (2) under Section VIII of this document).

regulatory language required the applicant to assess the impact of highway traffic generated by the proposed project on the level of service of local highways during periods of license renewal refurbishment activities and during the term of the renewed license. Therefore, applicants no longer need to assess the impacts on local traffic volumes of continued operations and refurbishment associated with license renewal in their environmental reports.

The issue was reclassified to Category 1 because refurbishment activities (such as steam generator and vessel head replacement) have not required the large numbers of workers and the months of time that was conservatively analyzed in the 1996 GEIS. As such, significant transportation impacts are not anticipated from future refurbishment activities. Section VIII, ''Final Actions and Basis for Changes to Table B–1,'' of this document discusses this issue in more detail under Issue 56, ''Transportation.''

Section 51.53(c)(3)(ii)(O). The proposed rule added a new paragraph 10 CFR 51.53(c)(3)(ii)(O) to address ''Groundwater and soil contamination'' as a Category 2 issue. However, based upon public comments received on the proposed rule [26] and further evaluation by the NRC, it was determined that this issue is properly classified as Category 1. Therefore, the proposed paragraph was not adopted by the final rule.[27]

B. Adding New Category 2 Issues

Section 51.53(c)(3)(ii)(N). The final rule adds a new paragraph 10 CFR 51.53(c)(3)(ii)(N) [28] to address ''Minority and low-income populations'' as a Category 2 issue. This new Category 2 issue is listed under the resource area ''Environmental Justice'' in the revised Table B–1. It addresses the effects of nuclear power plant operations and refurbishment associated with license renewal on minority populations and low-income populations living in the vicinity of the plant. This issue was listed in the original Table B–1 but was not evaluated in the 1996 GEIS. The finding in the original Table B–1 stated that ''[t]he need for and the content of an analysis of environmental justice will be addressed in plant specific reviews.'' This issue was not classified as either a Category 1 or 2 issue in the 1996 GEIS because guidance for implementing Executive Order (E.O.) 12898, dated February 16, 1994 (59 FR 7629), which initiated the Federal government's environmental justice program, was not available before the completion of the 1996 GEIS.

In August 2004, the Commission issued a policy statement on implementation of E.O. 12898: ''NRC's Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions'' (69 FR 52040). As stated therein, ''the NRC is committed to the general goals of E.O. 12898, [and] it will strive to meet those goals through its normal and traditional NEPA review process.'' By making this a Category 2 issue, the final rule requires license renewal applicants to identify, in their environmental reports, minority and low-income populations and communities residing in the vicinity of the nuclear power plant. The NRC will then assess the information provided by the applicant in the NRC's plant-specific environmental review.

Section 51.53(c)(3)(ii)(O). The final rule adds a new paragraph 10 CFR 51.53(c)(3)(ii)(O) [29] to address ''Cumulative impacts'' as a Category 2 issue. This new Category 2 issue was added to Table B–1 to evaluate the potential cumulative impacts of continued operations during the license renewal term and refurbishment associated with license renewal at nuclear power plants. The NRC did not address cumulative impacts in the 1996 GEIS but has been evaluating these impacts in plant-specific supplements to the GEIS. The Council on Environmental Quality (CEQ) in 40 CFR 1508.7 defines cumulative impacts as ''the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.'' [30] The NRC considers potential cumulative impacts on the environment resulting from the incremental impact of license renewal when added to other past, present, and reasonably foreseeable future actions.

The final rule change requires license renewal applicants to provide information about other past, present, and reasonably foreseeable future actions occurring in the vicinity of the nuclear power plant that may result in a cumulative impact. An example of the type of information to be provided includes data on the construction and operation of other power plants and other industrial commercial facilities in the vicinity of the nuclear power plant. Section VIII, ''Final Actions and Basis for Changes to Table B–1,'' of this document discusses this issue in more detail under Issue 73, ''Cumulative impacts.''

Section 51.53(c)(3)(ii)(P). The final rule adds a new paragraph 10 CFR 51.53(c)(3)(ii)(P) [31] to address ''Radionuclides released to groundwater'' as a Category 2 issue. This new Category 2 issue has been added to Table B–1 to evaluate the potential combined impact of inadvertent discharges of radioactive liquids from all plant systems into groundwater. The issue is relevant to license renewal because all commercial nuclear power plants have spent fuel pools, liquid storage tanks, and piping that contain and transport radioactive liquids. Over time, these systems and piping have a potential to degrade and release radioactive liquids that could migrate into the groundwater. The NRC has investigated several cases where radioactive liquids have been inadvertently released into the groundwater in an uncontrolled manner. In accordance with NRC requirements, residual activity from these inadvertent releases is subject to characterization and evaluation of the potential hazard. For this new Category 2 issue, the license renewal applicant is required to provide information on radioactive liquids released to groundwater.

In the final rule, the NRC modified the language of the proposed rule to specify that only ''documented'' releases need to be included in the applicant's environmental report. The NRC provides specific guidance on what constitutes a documented release in Regulatory Guide 4.2, Supplement 1, Revision 1, ''Preparation of Environmental Reports for Nuclear

[26] Section IV, ''Response to Public Comments,'' of this document provides a summary of the comments received on this issue.

[27] The final rule merges this issue into the consolidated issue, ''Groundwater contamination and use (non-cooling system impacts)'' (*see* Issue (20) under Section VIII of this document).

[28] The final rule adopts the proposed rule language.

[29] The proposed rule added this paragraph as 10 CFR 51.53(c)(3)(ii)(P). The final rule redesignates it as 10 CFR 51.53(c)(3)(ii)(O) because paragraph 10 CFR 51.53(c)(3)(ii)(O) of the proposed rule, which concerned ''Groundwater and soil contamination'' (*see* discussion in Section VI, ''A. Reclassifying Category 2 Issues as Category 1 Issues,'' of this document) was not adopted by the final rule.

[30] The NRC's regulations in 10 CFR part 51 incorporate the CEQ definition of cumulative impacts (10 CFR 51.14(b)).

[31] The proposed rule added this paragraph as 10 CFR 51.53(c)(3)(ii)(Q). The final rule redesignates it as paragraph 10 CFR 51.53(c)(3)(ii)(P) because the paragraph added as 10 CFR 51.53(c)(3)(ii)(O) by the proposed rule, which concerned groundwater and soil contamination caused by non-radionuclide, industrial contaminants, was not adopted by the final rule (*see* discussion in Section VI, ''A. Reclassifying Category 2 Issues as Category 1 Issues,'' of this document).

Power Plant License Renewal Applications.''

Section IV, ''Response to Public Comments,'' of this document provides a summary of the comments received on this issue, and Section VIII, ''Final Actions and Basis for Changes to Table B–1,'' of this document discusses this issue in more detail under Issue 27, ''Radionuclides released to groundwater.''

VII. Response to Specific Request for Voluntary Information

In Section VII of the Statement of Considerations for the July 31, 2009 (74 FR 38129–38130), proposed rule, the NRC requested voluntary information from industry about refurbishment activities and employment trends at nuclear power plants. Information on refurbishment would have been used to evaluate the significance of impacts from this type of activity. Information on employment trends would have been used to assess the significance of socioeconomic effects of ongoing plant operations on local economies.

The NRC received no response to these requests. The NRC interprets this lack of response on these issues to mean that information on major refurbishment and replacement activities and employment trends is either unavailable or insufficient to assist the NRC in re-evaluating the significance of refurbishment-related environmental impacts and socioeconomic effects of ongoing plant operations on local economies. Although no information was received regarding refurbishment activities and employment trends at nuclear power plants, the NRC believes that it has sufficient information based on lessons learned and knowledge gained from completed license renewal environmental reviews to substantiate the conclusions made in the final rule and GEIS.

VIII. Final Actions and Basis for Changes to Table B–1

The final rule revises Table B–1 to reflect the changes made in the revised GEIS. The revised GEIS is being made available with the final rule and provides a summary change table (in Appendix B) comparing the 92 environmental issues in the 1996 GEIS with the 78 environmental issues in the revised GEIS.

Land Use

(1) Onsite Land Use: ''Onsite land use'' remains a Category 1 issue. The final rule amends Table B–1 by making minor clarifying changes to the finding column entry for this issue. Specifically, the final rule replaces the sentence ''Projected onsite land use changes required during refurbishment and the renewal period would be a small fraction of any nuclear power plant site and would involve land that is controlled by the applicant,'' with ''Changes in onsite land use from continued operations and refurbishment associated with license renewal would be a small fraction of the nuclear power plant site and would involve only land that is controlled by the licensee.''

(2) Offsite Land Use: The final rule amends Table B–1 by consolidating two Category 2 issues, ''Offsite land use (refurbishment),'' with an impact level range small to moderate, and ''Offsite land use (license renewal term),'' with an impact level range small to large, and reclassifying the consolidated issue as a Category 1 issue, with an impact level of small, and naming the consolidated issue, ''Offsite land use.'' The final rule also creates a new Category 1 issue, ''Tax revenues'' (Issue 53), which concerns the impact of license renewal on state and local tax revenues, thereby removing tax revenues from the 1996 GEIS ''Offsite land use (license renewal term)'' issue. The final rule amends Table B–1 by removing the entries for ''Offsite land use (refurbishment)'' and ''Offsite land use (license renewal term),'' and by adding an entry for ''Offsite land use.'' The finding column entry of ''Offsite land use'' states ''[o]ffsite land use would not be affected by continued operations and refurbishment associated with license renewal.''

The Table B–1 finding column entry for the ''Offsite land use (refurbishment)'' issue indicated that impacts may be of moderate significance at plants in low population areas. Similarly, the finding column entry for the ''Offsite land use (license renewal term)'' issue indicates that significant changes (moderate to large) in land use may be associated with population and tax revenue changes resulting from license renewal. As described in the 1996 GEIS, environmental impacts are considered to be small if refurbishment activities were to occur at plants located in high population areas and if population and tax revenues would not change.

As reflected in the revised GEIS, significant impacts on offsite land use are not anticipated. Previous plant-specific license renewal reviews conducted by the NRC have shown no substantial increases in the number of workers during the license renewal term and that refurbishment activities (such as steam generator and vessel head replacement) have not required the large numbers of workers and the months of time that was conservatively estimated in the 1996 GEIS. These reviews support a finding that offsite land use impacts during the license renewal term would be small for all nuclear power plants.

(3) Offsite Land Use in Transmission Line Right-of-Ways (ROWs): The final rule amends Table B–1 by renaming the ''Power line right of way'' issue as ''Offsite land use in transmission line right-of-ways (ROWs).'' It remains a Category 1 issue with an impact level of small. The final rule amends the Table B–1 finding column entry for this issue by replacing the statement,

> Ongoing use of power line right of ways would continue with no change in restrictions. The effects of these restrictions are of small significance.

with the following:

> Use of transmission line ROWs from continued operations and refurbishment associated with license renewal would continue with no change in land use restrictions.

The final rule further amends Table B–1 by appending a footnote to the issue column entry for ''Offsite land use in transmission line right-of-ways (ROWs),'' concerning the extent to which transmission lines and their associated ROWs have been analyzed in the revised GEIS. The footnote states,

> This issue applies only to the in-scope portion of electric power transmission lines which are defined as transmission lines that connect the nuclear power plant to the substation where electricity is fed into the regional power distribution system and transmission lines that supply power to the nuclear plant from the grid.

As stated in the revised GEIS, the final environmental statements (essentially, the equivalent of environmental impact statements) prepared for the original construction of the various nuclear power plants (the construction permits) and for the initial operating licenses evaluated the impacts of those transmission lines built to connect the nuclear power plant to the regional electrical grid. Since the original construction of those lines, regional expansion of the electrical distribution grid has resulted in incorporation of those lines originating at the power plant substations. In most cases, the transmission lines originating at the power plant substations are no longer owned or managed by the nuclear power plant licensees. These lines would remain in place and be energized regardless of whether the subject nuclear power plant license was renewed or not. For this reason, those transmission lines that would not be impacted by a license renewal decision (i.e., those lines that would not be dismantled or otherwise decommissioned as a result of a plant terminating operations because its operating license had not been renewed) are considered beyond the scope of, and as such are not analyzed in, the revised GEIS.

Visual Resources

(4) Aesthetic Impacts: The final rule amends Table B–1 by consolidating three Category 1 issues, ''Aesthetic impacts (refurbishment),'' ''Aesthetic impacts (license renewal term),'' and ''Aesthetic impacts of transmission lines (license renewal term),'' each with an impact level of small, into one new Category 1 issue, ''Aesthetic impacts.'' The new consolidated issue also has an impact level of small. The 1996 GEIS concluded that renewal of operating licenses and the refurbishment activities would have no significant aesthetic impact during the license renewal term. Impacts are considered to be small if the visual appearance of plant and transmission line structures would not change. Previous license renewal reviews conducted by the NRC show that the appearance of nuclear power plants and transmission line structures do not change significantly over time or because of refurbishment activities. Therefore, because aesthetic impacts are not anticipated and the three issues are similar, they have been consolidated to facilitate the environmental review process. The final rule amends Table B–1 by removing the entries for ''Aesthetic impacts (refurbishment),'' ''Aesthetic impacts (license renewal term),'' and ''Aesthetic impacts of transmission lines (license renewal term),'' and adding an entry for ''Aesthetic impacts.'' The finding column entry for the new combined entry states ''[n]o important changes to the visual appearance of plant structures or transmission lines are expected from continued operations and refurbishment associated with license renewal.''

Air Quality

(5) Air Quality Impacts (All Plants): The final rule amends Table B–1 by renaming the ''Air quality during refurbishment (nonattainment and maintenance areas)'' issue as ''Air quality impacts (all plants).'' The final rule reflects the revised GEIS's expansion of the issue to include air emission impacts from emergency diesel generators, boilers, and particulate emissions from cooling towers. Based on public comments received on the proposed rule and the re-evaluation of information as described in the revised GEIS, the final rule further amends Table B–1 by revising this Category 2 issue, with an impact level range small to large, to a Category 1 issue with an impact level of small.[32] The final rule further amends Table B–1 by revising the finding column entry for this issue to state,

> Air quality impacts from continued operations and refurbishment associated with license renewal are expected to be small at all plants. Emissions resulting from refurbishment activities at locations in or near air quality nonattainment or maintenance areas would be short-lived and would cease after these refurbishment activities are completed. Operating experience has shown that the scale of refurbishment activities has not resulted in exceedance of the *de minimis* thresholds for criteria pollutants, and best management practices including fugitive dust controls and the imposition of permit conditions in State and local air emissions permits would ensure conformance with applicable State or Tribal Implementation Plans.
>
> Emissions from emergency diesel generators and fire pumps and routine operations of boilers used for space heating would not be a concern, even for plants located in or adjacent to nonattainment areas. Impacts from cooling tower particulate emissions even under the worst-case situations have been small.

Operating experience has shown that air quality impacts from these emission sources (including particulate emissions from cooling towers at operating plants) have been small at all nuclear power plants, including those plants located in or adjacent to nonattainment areas.

In addition, air quality impacts during refurbishment have also been small. These types of emissions could be a cause for concern if they occur at plants located in or near air quality nonattainment or maintenance areas. However, these impacts have been temporary and would cease once these activities were completed. Operating experience has also shown that refurbishment activities have not required the large numbers of workers and the months of time that was conservatively predicted and analyzed in the 1996 GEIS, nor have such activities resulted in exceedances in the *de minimis* thresholds for criteria pollutants in nonattainment and maintenance areas.

Implementation of best management practices, including fugitive dust controls as required by the imposition of conditions in State and local air emissions permits, would ensure conformance with applicable State or Tribal Implementation Plans, in accordance with EPA's revised General Conformity Regulations (75 FR 17254; April 5, 2010). On the basis of these considerations, the NRC has concluded that the air quality impact of continued nuclear power plant operations and refurbishment associated with license renewal would be small for all plants.

(6) Air Quality Effects of Transmission Lines: The final rule amends Table B–1 by appending a footnote to the issue column entry for ''Air quality effects of transmission lines,'' concerning the extent to which transmission lines and their associated right of ways have been analyzed under the revised GEIS. This footnote is the same one that was added to Issue 3, ''Offsite land use in transmission line right-of-ways (ROWs).'' See the description of the changes made by the final rule to Issue 3 for further explanation of this amendment.

Noise

(7) Noise Impacts: The final rule amends Table B–1 by renaming the issue ''Noise'' as ''Noise impacts.'' The issue remains a Category 1 issue with an impact level of small. The final rule further amends Table B–1 by making minor clarifying changes to the finding column entry for this issue. Specifically, the final rule replaces the sentence ''Noise has not been found to be a problem at operating plants and is not expected to be a problem at any plant during the license renewal term,'' with ''Noise levels would remain below regulatory guidelines for offsite receptors during continued operations and refurbishment associated with license renewal.''

Geologic Environment

(8) Geology and Soils: The final rule amends Table B–1 by adding a new Category 1 issue, ''Geology and soils.'' This issue has an impact level of small. The finding column entry for this issue states,

> The effect of geologic and soil conditions on plant operations and the impact of continued operations and refurbishment activities on geology and soils would be small for all nuclear power plants and would not change appreciably during the license renewal term.

This issue was not evaluated in the 1996 GEIS, as described in the proposed rule.[33] This new Category 1 issue considers geology and soils from the perspective of those resource conditions or attributes that can be affected by

[32] Under the proposed rule, the issue had been proposed to be renamed ''Air quality (nonattainment and maintenance areas);'' it would have remained a Category 2 issue with an impact level range of small to large (74 FR 38121, 38134; July 31, 2009).

[33] The proposed rule named the issue ''Impacts of nuclear plants on geology and soils.'' Under the proposed rule, the issue was also a Category 1 issue, with an impact level of small (74 FR 38121, 38134; July 31, 2009).

continued operations during the renewal term. The final rule does not require the license renewal applicant to assess this issue in its environmental report unless the applicant is aware of new and significant information about geologic and soil conditions and associated impacts at or near the nuclear power plant site that could change the conclusion in the GEIS.

An understanding of geologic and soil conditions has been well established at all nuclear power plants and associated transmission lines during the current licensing term, and these conditions are expected to remain unchanged during the 20-year license renewal term for each plant. The impact of these conditions on plant operations and the impact of continued power plant operations and refurbishment activities on geology and soils are small for all nuclear power plants and not expected to change appreciably during the license renewal term. Operating experience shows that any impacts to geologic and soil strata would be limited to soil disturbance from construction activities associated with routine infrastructure renovation and maintenance projects during continued plant operations. Implementing best management practices would reduce soil erosion and subsequent impacts on surface water quality. Information in plant-specific SEISs prepared to date and reference documents have not identified these impacts as being significant.

Surface Water Resources

(9) Surface Water Use and Quality (Non-Cooling System Impacts): The final rule amends Table B–1 by consolidating two Category 1 issues, ''Impacts of refurbishment on surface water quality'' and ''Impacts of refurbishment on surface water use,'' both with an impact level of small, and names the consolidated issue, ''Surface water use and quality (non-cooling system impacts).'' These two issues were consolidated because the impacts of refurbishment on both surface water use and quality are negligible and the effects are closely related. The consolidated issue has also been expanded to include the impacts of continued operations. The consolidated issue is a Category 1 issue with an impact level of small.

The final rule amends Table B–1 by removing the entries for ''Impacts of refurbishment on surface water quality'' and ''Impacts of refurbishment on surface water use'' and adding an entry for ''Surface water use and quality (non-cooling system impacts).'' The finding column entry for the new consolidated issue states,

> Impacts are expected to be small if best management practices are employed to control soil erosion and spills. Surface water use associated with continued operations and refurbishment associated with license renewal would not increase significantly or would be reduced if refurbishment occurs during a plant outage.

The NRC expects licensees to use best management practices during the license renewal term for both continuing operations and refurbishment activities. Use of best management practices will minimize soil erosion. In addition, implementation of spill prevention and control plans will reduce the likelihood of any liquid chemical spills. If refurbishment activities take place during a plant outage, with the reactor shutdown, the overall water use by the facility will be reduced. Based on this conclusion, the impact on surface water use and quality during the license renewal term will continue to be small for all plants.

(10) Altered Current Patterns at Intake and Discharge Structures, (11) Altered Salinity Gradients, (12) Altered Thermal Stratification of Lakes, and (13) Scouring Caused by Discharged Cooling Water: These four issues remain Category 1 issues, each with an impact level of small. The final rule amends Table B–1 by making minor clarifying changes to the finding column entries for each of these issues.

The final rule amends the ''Altered current patterns at intake and discharge structures'' finding column entry by replacing the statement,

> Altered current patterns have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

with the following:

> Altered current patterns would be limited to the area in the vicinity of the intake and discharge structures. These impacts have been small at operating nuclear power plants.

The final rule amends the ''Altered salinity gradients'' finding column entry by replacing the statement,

> Salinity gradients have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

with the following:

> Effects on salinity gradients would be limited to the area in the vicinity of the intake and discharge structures. These impacts have been small at operating nuclear power plants.

The final rule amends the ''Altered thermal stratification of lakes'' finding column entry by replacing the statement,

> Generally, lake stratification has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.

with the following:

> Effects on thermal stratification would be limited to the area in the vicinity of the intake and discharge structures. These impacts have been small at operating nuclear power plants.

The final rule amends the ''Scouring caused by discharged cooling water'' finding column entry by replacing the statement,

> Scouring has not been found to be a problem at most operating nuclear power plants and has caused only localized effects at a few plants. It is not expected to be a problem during the license renewal term.

with the following:

> Scouring effects would be limited to the area in the vicinity of the intake and discharge structures. These impacts have been small at operating nuclear power plants.

These changes reflect the findings of environmental reviews conducted since the publication of the 1996 GEIS, which show that the effects of these four issues are localized in the vicinity of the plant's intake and discharge structures.

(14) Discharge of Metals in Cooling System Effluent: The final rule amends Table B–1 by renaming ''Discharge of other metals in waste water'' as ''Discharge of metals in cooling system effluent.'' It remains a Category 1 issue with an impact level of small. The final rule also makes minor clarifying changes to the finding column entry for this issue. Specifically, the final rule amends the finding column entry by replacing the statement,

> These discharges have not been found to be a problem at operating nuclear power plants with cooling-tower-based heat dissipation systems and have been satisfactorily mitigated at other plants. They are not expected to be a problem during the license renewal term.

with the following:

> Discharges of metals have not been found to be a problem at operating nuclear power plants with cooling-tower-based heat dissipation systems and have been satisfactorily mitigated at other plants. Discharges are monitored and controlled as part of the National Pollutant Discharge Elimination System (NPDES) permit process.

(15) Discharge of Biocides, Sanitary Wastes, and Minor Chemical Spills: The final rule amends Table B–1 by consolidating two Category 1 issues, ''Discharge of chlorine or other biocides'' and ''Discharge of sanitary wastes and minor chemical spills,'' both with an impact level of small, and naming the consolidated issue ''Discharge of biocides, sanitary wastes,

and minor chemical spills.'' The consolidated issue is a Category 1 issue with an impact level of small. Specifically, the final rule amends Table B–1 by removing the entries for ''Discharge of chlorine or other biocides'' and ''Discharge of sanitary wastes and minor chemical spills'' and adding an entry for ''Discharge of biocides, sanitary wastes, and minor chemical spills.'' The finding column entry for the new consolidated issue states,

The effects of these discharges are regulated by Federal and State environmental agencies. Discharges are monitored and controlled as part of the NPDES permit process. These impacts have been small at operating nuclear power plants.

(16) *Surface Water Use Conflicts (Plants with Once-Through Cooling Systems):* ''Water use conflicts (plants with once-through cooling systems)'' remains a Category 1 issue with an impact level of small. The final rule amends Table B–1 by adding the word ''Surface'' to the title of this issue.

(17) *Surface Water Use Conflicts (Plants with Cooling Ponds or Cooling Towers Using Makeup Water from a River):* The final rule amends Table B–1 by adding the term ''surface'' and removing the terms ''small'' and ''low flow'' from the title and the associated numerical definition contained in 10 CFR 51.53(c)(3)(ii)(A) for low flow rivers from this and other related river flow issues. This issue remains a Category 2 issue with an impact range of small to moderate. The final rule also amends the finding column entry by replacing the statement,

The issue has been a concern at nuclear power plants with cooling ponds and at plants with cooling towers. Impacts on instream and riparian communities near these plants could be of moderate significance in some situations. See § 51.53(c)(3)(ii)(A).

with the following:

Impacts could be of small or moderate significance, depending on makeup water requirements, water availability, and competing water demands.

The 1996 GEIS distinguished between surface water use impacts during low flow conditions on ''small'' versus ''large'' rivers. Any river, regardless of size, can experience low flow conditions of varying severity during periods of drought and changing conditions in the affected watersheds such as upstream diversions and use of river water. Similarly, the NRC has determined that the use of the term ''low flow'' in categorizing river flow is of little value considering that plants that withdraw makeup water from a river can experience low flow conditions and would be required to conduct a plant-specific assessment of water use conflicts.

(18) *Effects of Dredging on Surface Water Quality:* The final rule amends Table B–1 by adding a new Category 1 issue, ''Effects of dredging on surface water quality,'' which evaluates the impacts of dredging to maintain intake and discharge structures at nuclear power plant facilities. This issue has an impact level of small. The finding column entry for this issue states,

Dredging to remove accumulated sediments in the vicinity of intake and discharge structures and to maintain barge shipping has not been found to be a problem for surface water quality. Dredging is performed under permit from the U.S. Army Corps of Engineers, and possibly, from other State or local agencies.

The impact of dredging on surface water quality was not considered in the 1996 GEIS and was not listed in Table B–1 prior to this final rule. Most plants have intake and discharge structures that must be maintained by periodic dredging of sediment accumulated in or on the structures. The NRC has found that dredging, while temporarily increasing turbidity in the source water body, generally has little long-term effect on water quality. In addition to maintaining intake and discharge structures, dredging is often done to keep barge slips and channels open to service the plant. Dredged material is most often disposed on property owned by the applicant and usually contains no hazardous materials. Dredging must be performed under a permit issued by the U.S. Army Corps of Engineers (the Corps) and consequently, each dredging action would be subject to a site-specific environmental review conducted by the Corps. Temporary impacts of dredging are measurable in general water quality terms, but the impacts have been shown to be small.

(19) *Temperature Effects on Sediment Transport Capacity:* There are no changes to this issue, and it remains a Category 1 issue with an impact level of small.

Groundwater Resources

(20) *Groundwater Contamination and Use (Non-Cooling System Impacts):* The final rule amends Table B–1 by expanding the scope of ''Impacts of refurbishment on groundwater use and quality'' issue to include the effects of continued nuclear power plant operations during the license renewal term. This Category 1 issue, with an impact level of small, was renamed ''Groundwater use and quality'' in the proposed rule.

The final rule also amends Table B–1 by changing the proposed rule's new Category 2 issue ''Groundwater and soil contamination,'' with an impact range of small to moderate (see 74 FR 38122, 38135), to Category 1, with an impact level of small. This issue was then consolidated with the ''Groundwater use and quality'' issue and renamed ''Groundwater contamination and use (non-cooling system impacts).'' These issues were consolidated because they consider the impact of industrial activities associated with the continued operations of a nuclear power plant (not directly related to cooling system effects) and refurbishment on groundwater use and quality. The final rule further amends Table B–1 by replacing the finding column entry, which states,

Extensive dewatering during the original construction on some sites will not be repeated during refurbishment on any sites. Any plant wastes produced during refurbishment will be handled in the same manner as in current operating practices and are not expected to be a problem during the license renewal term.

with the following:

Extensive dewatering is not anticipated from continued operations and refurbishment associated with license renewal. Industrial practices involving the use of solvents, hydrocarbons, heavy metals, or other chemicals, and/or the use of wastewater ponds or lagoons have the potential to contaminate site groundwater, soil, and subsoil. Contamination is subject to State or Environmental Protection Agency regulated cleanup and monitoring programs. The application of best management practices for handling any materials produced or used during these activities would reduce impacts.

The consolidated Category 1 issue considers the impacts from groundwater use and the impacts on groundwater, soil, and subsoil from the industrial use of solvents, hydrocarbons, heavy metals, or other chemicals at nuclear power plant sites from continued operation during the license renewal term and refurbishment. The consolidated issue also includes the use of wastewater disposal ponds or lagoons and non-radionuclide, industrial contaminants released inadvertently or as effluents into the environment. Industrial practices at all nuclear power plants have the potential to contaminate groundwater and soil, especially on sites with unlined wastewater and storm water ponds or lagoons. Any contamination of this type is subject to characterization and clean-up under EPA or State regulated remediation and monitoring programs.

Non-radionuclide contaminants have been found in groundwater and soil samples at some nuclear power plants during previous license renewal environmental reviews. Release of these contaminants into groundwater and soil degrades the quality of these resources, even if applicable groundwater quality standards are not exceeded. However, each site has its own program for handling chemicals, waste, and other hazardous materials in accordance with Federal and State regulations and is expected to employ best management practices. The use of wastewater disposal ponds or lagoons, whether lined or unlined, may increase the potential for groundwater and soil contamination. However, they are subject to discharge authorizations under NPDES and related State wastewater discharge permit programs.

The finding column of Table B–1 for ''Groundwater use and quality'' prior to this final rule, as analyzed in the 1996 GEIS, indicated that impacts of continued operations and refurbishment on groundwater use and quality would be small, as extensive dewatering is not anticipated. This finding was re-evaluated in the revised GEIS and is retained in Table B–1.

While the proposed rule's ''Groundwater and soil contamination'' issue was identified as a Category 2 issue, further consideration of the ''Groundwater and soil contamination'' issue and public comments revealed that the potential impacts on groundwater and soil quality from common industrial practices can be addressed generically, as these practices are common to all industrial facilities and are not unique to nuclear power plants. Moreover, as supported by the analysis in the revised GEIS, the NRC concludes that the overall impact of industrial practices on groundwater use and quality from past and current operations is small for all nuclear power plants and not expected to change appreciably during the license renewal term.

(21) *Groundwater Use Conflicts (Plants that Withdraw Less Than 100 Gallons per Minute [gpm]):* The final rule amends Table B–1 by renaming the ''Ground-water use conflicts (potable and service water; plants that use <100 gpm)'' issue as ''Groundwater use conflicts (plants that withdraw less than 100 gallons per minute [gpm]).'' It remains a Category 1 issue with an impact level of small. The final rule further amends Table B–1 by making minor clarifying changes to the finding column entry for this issue. Specifically, the final rule replaces the entry statement ''Plants using less than 100 gpm are not expected to cause any ground-water conflicts,'' with ''Plants that withdraw less than 100 gpm are not expected to cause any groundwater use conflicts.''

(22) *Groundwater Use Conflicts (Plants that Withdraw More Than 100 Gallons per Minute [gpm]):* The final rule amends Table B–1 by consolidating two Category 2 issues, ''Groundwater use conflicts (potable and service water, and dewatering; plants that use >100 gpm)'' and ''Ground-water use conflicts (Ranney wells),'' each with an impact level range of small to large, and names the consolidated issue, ''Groundwater use conflicts (plants that withdraw more than 100 gallons per minute [gpm]).'' Because Ranney wells produce significantly more than 100 gpm, the Ranney wells issue was consolidated with the general issue of groundwater use conflicts for plants using more than 100 gpm of groundwater. The consolidated issue is a Category 2 issue, with an impact level range of small to large. The final rule further amends Table B–1 by removing the entries for ''Groundwater use conflicts (potable and service water, and dewatering; plants that use >100 gpm)'' and ''Ground-water use conflicts (Ranney wells)'' and adding an entry for ''Groundwater use conflicts (plants that withdraw more than 100 gallons per minute [gpm]).'' The finding column entry for the new consolidated issue states ''Plants that withdraw more than 100 gpm could cause groundwater use conflicts with nearby groundwater users.''

(23) *Groundwater Use Conflicts (Plants with Closed-Cycle Cooling Systems that Withdraw Makeup Water from a River):* The final rule amends Table B–1 by renaming ''Ground-water use conflicts (plants using cooling towers withdrawing makeup water from a small river)'' as ''Groundwater use conflicts (plants with closed-cycle cooling systems that withdraw makeup water from a river).'' It remains a Category 2 issue, with an impact level range of small to large. The final rule further amends Table B–1 by replacing the finding column entry, which states,

> Water use conflicts may result from surface water withdrawals from small water bodies during low flow conditions which may affect aquifer recharge, especially if other ground-water or upstream surface water users come on line before the time of license renewal. See § 51.53(c)(3)(ii)(A).

with the following:

> Water use conflicts could result from water withdrawals from rivers during low-flow conditions, which may affect aquifer recharge. The significance of impacts would depend on makeup water requirements, water availability, and competing water demands.

The 1996 GEIS distinguished between surface water use impacts during low flow conditions on ''small'' versus ''large'' rivers. Any river, regardless of size, can experience low flow conditions of varying severity during periods of drought and changing conditions in the affected watersheds such as upstream diversions and use of river water. The NRC has thus determined that the use of the term ''small river'' or ''small water bodies'' is of little value considering that plants that withdraw makeup water from a river can experience low-flow conditions and would be required to conduct a plant-specific assessment of water use conflicts.

(24) *Groundwater Quality Degradation Resulting from Water Withdrawals:* The final rule amends Table B–1 by consolidating two Category 1 issues, ''Ground-water quality degradation (Ranney wells)'' and ''Ground-water quality degradation (saltwater intrusion),'' each with an impact level of small, and names the consolidated issue, ''Groundwater quality degradation resulting from water withdrawals.'' The consolidated issue remains a Category 1 issue, with an impact level of small. The final rule further amends Table B–1 by removing the entries for ''Ground-water quality degradation (Ranney wells)'' and ''Ground-water quality degradation (saltwater intrusion)'' and, by adding an entry for ''Groundwater quality degradation resulting from water withdrawals.'' The finding column entry for the consolidated issue states ''Groundwater withdrawals at operating nuclear power plants would not contribute significantly to groundwater quality degradation.'' The two issues were consolidated as they both consider the possibility of groundwater quality becoming degraded as a result of plant operations drawing water of potentially lower quality into the aquifer.

(25) Groundwater Quality Degradation (Plants with Cooling Ponds in Salt Marshes): The final rule amends Table B–1 by revising the title of the issue ''Ground-water quality degradation (cooling ponds in salt marshes)'' to ''Groundwater quality degradation (plants with cooling ponds in salt marshes).'' The issue remains a Category 1 issue, with an impact level of small. The final rule further amends Table B–1 by replacing the finding column entry, which states,

> Sites with closed-cycle ponds may degrade ground-water quality. Because water in salt marshes is brackish, this is not a concern for plants located in salt marshes.

with the following:

Sites with closed-cycle cooling ponds could degrade groundwater quality. However, groundwater in salt marshes is naturally brackish and thus, not potable. Consequently, the human use of such groundwater is limited to industrial purposes.

The final rule change to the finding column entry reflects the NRC's response to a public comment on the proposed rule by: (1) Deleting the term ''plants'' to eliminate any confusion that the NRC might have meant marsh ''plants'' rather than ''nuclear power plants;'' and (2) clarifying that the focus of this issue is on the degradation of groundwater quality for human use. Brackish groundwater has limited human use, thus, any impacts on groundwater quality caused by continued operations and refurbishment associated with license renewal are not significant.

(26) Groundwater Quality Degradation (Plants with Cooling Ponds at Inland Sites): The final rule amends Table B–1 by revising the title of the issue ''Ground-water quality degradation (cooling ponds at inland sites)'' to ''Groundwater quality degradation (plants with cooling ponds at inland sites).'' The issue remains a Category 2 issue, with an impact level range of small to large. The final rule further amends Table B–1 by replacing the finding column entry, which states,

Sites with closed-cycle cooling ponds may degrade ground-water quality. For plants located inland, the quality of the ground water in the vicinity of the ponds must be shown to be adequate to allow continuation of current uses. See § 51.53(c)(3)(ii)(D).

with the following:

Inland sites with closed-cycle cooling ponds could degrade groundwater quality. The significance of the impact would depend on cooling pond water quality, site hydrogeologic conditions (including the interaction of surface water and groundwater), and the location, depth, and pump rate of water wells.

(27) *Radionuclides Released to Groundwater:* The final rule amends Table B–1 by adding a new Category 2 issue, ''Radionuclides released to groundwater,'' with an impact level range of small to moderate, to evaluate the potential impact of discharges of radionuclides from plant systems into groundwater. The finding column entry for this issue states,

Leaks of radioactive liquids from plant components and pipes have occurred at numerous plants. Groundwater protection programs have been established at all operating nuclear power plants to minimize the potential impact from any inadvertent releases. The magnitude of impacts would depend on site-specific characteristics.

This new Category 2 issue has been added to evaluate the potential impact to groundwater quality from the discharge of radionuclides from plant systems, piping, and tanks. This issue was added because within the past several years there have been events at nuclear power reactor sites that involved unknown, uncontrolled, and unmonitored releases of radioactive liquids into the groundwater. The issue is relevant to license renewal because this experience has shown that components and piping at nuclear power plants have the potential to leak radioactive material into the groundwater and degrade its quality. While the NRC's regulations in 10 CFR part 20 and in 10 CFR part 50 limit the amount of radioactive material released (i.e., from routine and inadvertent sources) from a nuclear power plant into the environment, the regulations are focused on protecting the public, not the quality of the groundwater. Therefore, as required by NEPA, the NRC must consider the potential impacts to the groundwater from radioactive liquids released into groundwater.

The majority of the inadvertent radioactive liquid release events involved tritium, which is a radioactive isotope of hydrogen. However, in some of the events, radioactive isotopes of cesium and strontium have also been released. Non-routine releases of radioactive liquids into the groundwater have occurred from plant systems and buried piping.

In 2006, the NRC's Executive Director for Operations chartered a task force to conduct a lessons-learned review of these incidents. On September 1, 2006, the Task Force issued its report: ''Liquid Radioactive Release Lessons Learned Task Force Report'' (ADAMS Accession No. ML062650312). A significant conclusion of the report dealt with the potential health impacts to the public from the inadvertent releases. Although there were numerous events where radioactive liquids were released to the groundwater in an unplanned, uncontrolled, and unmonitored fashion, based on the data available, the task force did not identify any instances where public health and safety was adversely impacted. However, the task force did not evaluate the impact of the releases to groundwater quality. The task force also identified that under the existing regulatory requirements, the potential exists for radioactive liquid releases from leaking systems to not be detected for a period of time and, therefore, the contaminants could migrate into groundwater.

In response to these groundwater events, NEI, which represents the nuclear industry, in 2007 committed to the NRC to develop a voluntary initiative for each nuclear power plant to have a site-specific groundwater protection program. NEI provided guidance to the nuclear industry (NEI 07–07, ADAMS Accession No. ML072610036) on the development and implementation of a groundwater protection program. The program covers the assessment of plant systems and components, site hydrogeology, and methods to detect leaks to determine the needs for each site-specific program. To monitor the actions of the nuclear industry, the NRC routinely inspects nuclear power plant licensees to verify continued implementation of the Groundwater Protection Initiative programs, to review records of identified leakage and spill events, to assess whether the source of the leak or spill was identified and mitigated, and to review any remediation actions taken for effectiveness.

On the basis of the information and experience with these groundwater events and the evaluation in the revised GEIS, the NRC concludes that the impact to groundwater quality from the release of radionuclides is dependent on site-specific variables and could be small or moderate, depending on the magnitude of the leak, radionuclides involved, and the response time of plant personnel to identify and stop the leak in a timely fashion. Therefore, ''Radionuclides released to groundwater'' is a Category 2 issue and, as such, a site-specific evaluation in the environmental report is needed for each application for license renewal. Similarly, the NRC will analyze this issue in the SEIS for each license renewal action.

Terrestrial Resources

(28) *Effects on Terrestrial Resources (Non-Cooling System Impacts):* The final rule amends Table B–1 by renaming the ''Refurbishment impacts'' issue as ''Effects on terrestrial resources (non-cooling system impacts).'' It remains a Category 2 issue, with an impact level range of small to large.[34] The issue, as set forth in the 1996 GEIS, addressed only the impacts upon terrestrial resources resulting from any refurbishment activities during the license renewal term. The analysis in the revised GEIS builds on the analysis in the 1996 GEIS to include the environmental impacts resulting from continued plant operations during the license renewal term. The final rule

[34] The proposed rule named the issue, ''Impacts of continued plant operations on terrestrial ecosystems'' (74 FR 38123, 38136; July 31, 2009).

further amends Table B–1 by replacing the finding column entry, which states,

Refurbishment impacts are insignificant if no loss of important plant and animal habitat occurs. However, it cannot be known whether important plant and animal communities may be affected until the specific proposal is presented with the license renewal application. See § 51.53(c)(3)(ii)(E).

with the following:

Impacts resulting from continued operations and refurbishment associated with license renewal may affect terrestrial communities. Application of best management practices would reduce the potential for impacts. The magnitude of impacts would depend on the nature of the activity, the status of the resources that could be affected, and the effectiveness of mitigation.

(29) *Exposure of Terrestrial Organisms to Radionuclides:* The final rule amends Table B–1 by adding a new Category 1 issue, ''Exposure of terrestrial organisms to radionuclides.'' The new issue has been determined to have an impact level of small. The finding column entry for this issue states,

Doses to terrestrial organisms from continued operations and refurbishment associated with license renewal are expected to be well below exposure guidelines developed to protect these organisms.

This new issue evaluates the potential impact of radionuclides on terrestrial organisms resulting from continued operations of a nuclear power plant during the license renewal term and refurbishment associated with license renewal. This issue was not evaluated in the 1996 GEIS. Subsequent to the publication of the 1996 GEIS, however, members of the public and various Federal and State agencies commented on the need to evaluate the potential impact of radionuclides on terrestrial organisms during plant-specific license renewal reviews.

The revised GEIS evaluates the potential impact of radionuclides on terrestrial biota at nuclear power plants from continued operations during the license renewal term. For the evaluation, site-specific radionuclide concentrations in environmental media (e.g., water, air, milk, crops, food products, sediment, and fish and other aquatic biota) were obtained from publicly available Radiological Environmental Monitoring Program (REMP) annual reports from 15 nuclear power plants. The REMP is conducted at every NRC licensed nuclear power plant to assess the environmental impacts from plant operations. This is done by collecting samples of environmental media from areas surrounding the plant for analysis to measure the amount of radioactivity, if any, in the samples. The media samples reflect the radiation exposure pathways to the public from radioactive effluents released by the nuclear power plant and from background radiation (i.e., cosmic sources, naturally-occurring radioactive material, including radon and global fallout). These 15 plants were selected to represent sites that reported a range of radionuclide concentrations in the sample media and included both boiling water reactors and pressurized water reactors. Site-specific radionuclide concentrations in water and sediments, as reported in the plant's REMP reports, were used in the calculations. The calculated radiation dose rates to terrestrial biota, based on exposure to radioactivity in the environmental media, were compared against radiation-safety guidelines issued by the U.S. Department of Energy (DOE), the International Atomic Energy Agency (IAEA), the National Council of Radiation Protection and Measurements (NCRP), and the International Commission on Radiological Protection (ICRP). The NRC concluded that the impacts of radionuclides on terrestrial biota from past and current normal operations are small for all nuclear power plants and should not change appreciably during the license renewal term.

(30) *Cooling System Impacts on Terrestrial Resources (Plants with Once-Through Cooling Systems or Cooling Ponds):* The final rule amends Table B–1 by renaming the ''Cooling pond impacts on terrestrial resources'' issue as ''Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds).'' It remains a Category 1 issue, with an impact level of small. The analysis in the revised GEIS expands the scope of this issue to include plants with once-through cooling systems. This analysis concludes that the impacts on terrestrial resources from once-through cooling systems, as well as from cooling ponds, is of small significance at all plants. The final rule further amends Table B–1 by replacing the finding column entry, which states,

Impacts of cooling ponds on terrestrial ecological resources are considered to be of small significance at all sites.

with the following:

No adverse effects to terrestrial plants or animals have been reported as a result of increased water temperatures, fogging, humidity, or reduced habitat quality. Due to the low concentrations of contaminants in cooling system effluents, uptake and accumulation of contaminants in the tissues of wildlife exposed to the contaminated water or aquatic food sources are not expected to be significant issues.

(31) *Cooling Tower Impacts on Vegetation (Plants with Cooling Towers):* The final rule amends Table B–1 by consolidating two Category 1 issues, ''Cooling tower impacts on crops and ornamental vegetation'' and ''Cooling tower impacts on native plants,'' both issues having an impact level of small, and names the consolidated issue, ''Cooling tower impacts on vegetation (plants with cooling towers).'' The consolidated issue is a Category 1 issue with an impact level of small. The two issues were consolidated to conform to the resource-based approach used in the revised GEIS. With the recent trend of replacing lawns with native vegetation, some ornamental plants and crops are native plants, and the original separation into two issues is unnecessary and cumbersome. The final rule further amends Table B–1 by removing the entries for ''Cooling tower impacts on crops and ornamental vegetation'' and ''Cooling tower impacts on native plants,'' and by adding an entry for ''Cooling tower impacts on vegetation (plants with cooling towers).'' The finding column entry for the new consolidated issue states,

Impacts from salt drift, icing, fogging, or increased humidity associated with cooling tower operation have the potential to affect adjacent vegetation, but these impacts have been small at operating nuclear power plants and are not expected to change over the license renewal term.

(32) *Bird Collisions with Plant Structures and Transmission Lines:* The final rule amends Table B–1 by consolidating two Category 1 issues, ''Bird collisions with cooling towers'' and ''Bird collision with power lines,'' both issues having an impact level of small. The final rule also expands the scope of the consolidated issue to address collisions with all plant structures and names the issue, ''Bird collisions with plant structures and transmission lines.'' The consolidated issue is a Category 1 issue with an impact level of small. The two issues were consolidated to conform to the resource-based approach used in the revised GEIS. The final rule further amends Table B–1 by removing the entries for ''Bird collisions with cooling towers'' and ''Bird collision with power lines,'' and by adding an entry for ''Bird collisions with plant structures and transmission lines.'' The finding column entry for the new consolidated issue states,

Bird collisions with cooling towers and other plant structures and transmission lines occur at rates that are unlikely to affect local or migratory populations and the rates are not expected to change.

The final rule further amends Table B–1 by appending a footnote to the issue column entry for ''Bird collisions with plant structures and transmission lines,'' concerning the extent to which transmission lines and their associated right of ways have been analyzed under the revised GEIS. This footnote is the same one that was added to Issue 3, ''Offsite land use in transmission line right-of-ways (ROWs).'' See the description of the changes made by the final rule to Issue 3 for further explanation of this amendment.

(33) *Water Use Conflicts with Terrestrial Resources (Plants with Cooling Ponds or Cooling Towers Using Makeup Water from a River):* The final rule amends Table B–1 by adding a new Category 2 issue, ''Water use conflicts with terrestrial resources (plants with cooling ponds or cooling towers using makeup water from a river),'' to evaluate water use conflict impacts with terrestrial resources in riparian communities. The 1996 GEIS already addresses the resource aspects of this issue, and 10 CFR 51.53(c)(3)(ii)(A) requires a plant-specific analysis of the impacts of surface water withdrawals from rivers for cooling pond or cooling tower makeup on riparian ecological communities. However, this stand-alone issue was created to clearly separate out the related aspects and potential impacts on terrestrial, riparian communities associated with surface water withdrawals from a river for consumptive cooling water uses. The new issue has an impact level range of small to moderate. The finding column entry for this issue states,

Impacts on terrestrial resources in riparian communities affected by water use conflicts could be of moderate significance.

As described in the revised GEIS, such impacts could occur when water that supports these resources is diminished because of decreased availability due to droughts; increased water demand for agricultural, municipal, or industrial usage; or a combination of these factors. The potential range of impact levels at plants, subject to license renewal, with cooling ponds or cooling towers using makeup water from a river cannot be generically determined. The NRC has also removed the term ''low flow'' from the title of this issue, as set forth in the proposed rule, and other related river flow issues in the final rule as previously discussed in this section (*see* Issue 17, ''Surface Water Use Conflicts (Plants with Cooling Ponds or Cooling Towers Using Makeup Water from a River)'').

(34) *Transmission Line Right-of-Way (ROW) Management Impacts on Terrestrial Resources:* The final rule amends Table B–1 by consolidating two Category 1 issues, ''Power line right-of-way management (cutting and herbicide application)'' and ''Floodplains and wetland on power line right-of-way,'' each with an impact level of small, and names the consolidated issue, ''Transmission line right-of-way (ROW) management impacts on terrestrial resources.'' The consolidated issue is a Category 1 issue, with an impact level of small. The two issues were consolidated to conform to the resource-based approach used in the revised GEIS. The final rule further amends Table B–1 by removing the entries for ''Power line right-of-way management (cutting and herbicide application)'' and ''Floodplains and wetland on power line right-of-way,'' and, by adding an entry for ''Transmission line right-of-way (ROW) management impacts on terrestrial resources.'' The finding column entry for the consolidated issue states,

Continued ROW management during the license renewal term is expected to keep terrestrial communities in their current condition. Application of best management practices would reduce the potential for impacts.

The final rule further amends Table B–1 by appending a footnote to the issue column entry for ''Transmission line right-of-way (ROW) management impacts on terrestrial resources,'' concerning the extent to which transmission lines and their associated rights of way have been analyzed under the revised GEIS. This footnote is the same one that was added to Issue 3, ''Offsite land use in transmission line right-of-ways (ROWs).'' See the description of the changes made by the final rule to Issue 3 for further explanation of this amendment.

(35) Electromagnetic Fields on Flora and Fauna (Plants, Agricultural Crops, Honeybees, Wildlife, Livestock): There are no changes to this issue, and it remains a Category 1 issue with a small level of impact. The final rule amends Table B–1 by appending a footnote to the issue column entry for ''Electromagnetic Fields on Flora and Fauna (Plants, Agricultural Crops, Honeybees, Wildlife, Livestock),'' concerning the extent to which transmission lines and their associated rights of way have been analyzed under the revised GEIS. This footnote is the same one that was added to Issue 3, ''Offsite land use in transmission line right-of-ways (ROWs).'' See the description of the changes made by the final rule to Issue 3 for further explanation of this amendment.

Aquatic Resources

(36) *Impingement and Entrainment of Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds):* The final rule amends Table B–1 by consolidating two Category 2 issues, ''Entrainment of fish and shellfish in early life stages (for plants with once-through cooling and cooling pond heat dissipation systems)'' and ''Impingement of fish and shellfish (for plants with once-through cooling and cooling pond heat dissipation systems),'' both with impact level ranges of small to large, and names the consolidated issue, ''Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds).'' The consolidated issue is a Category 2 issue with an impact level range of small to large. The final rule further amends Table B–1 by removing the entries for ''Entrainment of fish and shellfish in early life stages (for plants with once-through cooling and cooling pond heat dissipation systems)'' and ''Impingement of fish and shellfish (for plants with once-through cooling and cooling pond heat dissipation systems),'' and, by adding an entry for ''Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds).'' The finding column entry for the consolidated issue states,

The impacts of impingement and entrainment are small at many plants, but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems, depending on cooling system withdrawal rates and volumes and the aquatic resources at the site.

For the revised GEIS, these issues were consolidated to facilitate the review process in keeping with the resource-based approach and to allow for a more complete analysis of the environmental impact. Nuclear power plants typically conduct separate sampling programs to estimate the numbers of organisms entrained and impinged, which explains the original separation of these issues. However, it is the consolidated effects of entrainment and impingement that reflect the total impact of the cooling system intake on the resource. Environmental conditions are different at each nuclear power plant site, and impacts cannot be determined generically.

(37) *Impingement and Entrainment of Aquatic Organisms (Plants with Cooling Towers):* The final rule amends Table B–1 by consolidating two Category 1 issues, ''Entrainment of fish and shellfish in early life stages (for plants with cooling tower-based heat dissipation systems)'' and ''Impingement of fish and shellfish (for plants with cooling tower-based heat dissipation systems),'' both with impact levels of small, and names the consolidated issue, ''Impingement and entrainment of aquatic organisms (plants with cooling towers).'' The consolidated issue is a Category 1 issue with an impact level of small. The final rule further amends Table B–1 by removing the entries for ''Entrainment of fish and shellfish in early life stages (for plants with cooling tower-based heat dissipation systems)'' and ''Impingement of fish and shellfish (for plants with cooling tower-based heat dissipation systems),'' and by adding an entry for ''Impingement and entrainment of aquatic organisms (plants with cooling towers).'' The finding column entry for the consolidated issue states,

> Impingement and entrainment rates are lower at plants that use closed-cycle cooling with cooling towers because the rates and volumes of water withdrawal needed for makeup are minimized.

The two issues have been consolidated given their similar nature and to facilitate the environmental review process consistent with the resource-based approach in the revised GEIS.

(38) Entrainment of phytoplankton and zooplankton (all plants): There are no changes to this issue, and it remains a Category 1 issue with an impact level of small. The proposed rule had consolidated two Category 2 issues, ''Entrainment of fish and shellfish in early life stages (for plants with once-through cooling and cooling pond heat dissipation systems)'' and ''Impingement of fish and shellfish (for plants with once-through cooling and cooling pond heat dissipation systems)'' with the Category 1 issue, ''Entrainment of phytoplankton and zooplankton (for all plants)'' (74 FR 38124, 38136; July 31, 2009). Under the proposed rule, the consolidated issue would have been a Category 2 issue, with an impact range of small to large. Subsequent to the publication of the proposed rule, the NRC determined that such consolidation would have the effect of making ''Entrainment of phytoplankton and zooplankton (all plants),'' which is an issue generic to all plants (Category 1), a site-specific issue (Category 2). As there is no basis to support making the ''Entrainment of phytoplankton and zooplankton (all plants)'' a site-specific issue, the NRC determined not to adopt the proposed rule change. Instead, only the two Category 2 issues were consolidated (*see* Issue 36), and this issue remains separate.

(39) *Thermal Impacts on Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds):* The final rule amends Table B–1 by renaming the issue, ''Heat shock (for plants with once-through and cooling pond heat dissipation systems)'' as ''Thermal Impacts on Aquatic Organisms (plants with once-through cooling systems or cooling ponds).'' It remains a Category 2 issue with an impact level range of small to large. The final rule further amends Table B–1 by replacing the finding column entry for this issue, which states,

> Because of continuing concerns about heat shock and the possible need to modify thermal discharges in response to changing environmental conditions, the impacts may be of moderate or large significance at some plants. See § 51.53(c)(3)(ii)(B).

with the following:

> Most of the effects associated with thermal discharges are localized and are not expected to affect overall stability of populations or resources. The magnitude of impacts, however, would depend on site-specific thermal plume characteristics and the nature of aquatic resources in the area.

Environmental conditions are different at each nuclear power plant site, and thermal impacts associated with once-through and cooling pond heat dissipation systems cannot be determined generically. The proposed rule had consolidated the Category 2 issue, ''Heat shock (for plants with once-through and cooling pond heat dissipation systems)'' with four Category 1 issues, ''Cold shock (for all plants),'' ''Thermal plume barrier to migrating fish (for all plants),'' ''Distribution of aquatic organisms (for all plants),'' and ''Premature emergence of aquatic insects (for all plants)'' (74 FR 38124, 38136; July 31, 2009). These issues were proposed for consolidation to facilitate the environmental review process because they are all caused by thermal effects. The final rule consolidates these four Category 1 issues with another Category 1 issue, ''Stimulation of nuisance organisms (e.g., shipworms),'' as Issue 41, ''Infrequently reported thermal impacts (all plants),'' as described later in this section.

(40) *Thermal Impacts on Aquatic Organisms (Plants with Cooling Towers):* The final rule amends Table B–1 by renaming the issue ''Heat shock (for plants with cooling-tower-based heat dissipation systems)'' as ''Thermal Impacts on Aquatic Organisms (Plants with Cooling Towers).'' It remains a Category 1 issue with an impact level of small. The final rule further amends Table B–1 by replacing the finding column entry for this issue, which states, ''Heat shock has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term,'' with the following, ''Thermal effects associated with plants that use cooling towers are expected to be small because of the reduced amount of heated discharge.''

The proposed rule had consolidated the Category 1 issue, ''Heat shock (for plants with cooling-tower-based heat dissipation systems)'' with four other Category 1 issues, ''Cold shock (for all plants),'' ''Thermal plume barrier to migrating fish (for all plants),'' ''Distribution of aquatic organisms (for all plants),'' and ''Premature emergence of aquatic insects (for all plants)'' (74 FR 38124, 38136). These issues were proposed for consolidation to facilitate the environmental review process because they are all caused by thermal effects. The final rule consolidates these four Category 1 issues with another Category 1 issue, ''Stimulation of nuisance organisms (e.g., shipworms),'' as Issue 41, ''Infrequently reported thermal impacts (all plants),'' as described in the following paragraphs.

(41) *Infrequently Reported Thermal Impacts (All Plants):* The final rule amends Table B–1 by consolidating five Category 1 issues, ''Cold shock (for all plants),'' ''Thermal plume barrier to migrating fish (for all plants),'' ''Distribution of aquatic organisms (for all plants),'' ''Premature emergence of aquatic insects (for all plants),'' and ''Stimulation of Nuisance Organisms (e.g., Shipworms),'' each with an impact level of small, and names the consolidated issue, ''Infrequently reported thermal impacts (all plants).'' The consolidated issue is a Category 1 issue, with an impact level of small. The final rule further amends Table B–1 by removing the entries for ''Cold shock (for all plants),'' ''Thermal plume barrier to migrating fish (for all plants),'' ''Distribution of aquatic organisms (for all plants),'' ''Premature emergence of aquatic insects (for all plants),'' and ''Stimulation of Nuisance Organisms (e.g., Shipworms),'' and, by adding an entry for ''Infrequently reported thermal impacts (all plants).'' The finding column entry for the new consolidated issue states,

Continued operations during the license renewal term are expected to have small thermal impacts with respect to the following:

Cold shock has been satisfactorily mitigated at operating nuclear plants with once-through cooling systems, has not endangered fish populations or been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds, and is not expected to be a problem.

Thermal plumes have not been found to be a problem at operating nuclear power plants and are not expected to be a problem.

Thermal discharge may have localized effects but is not expected to affect the larger geographical distribution of aquatic organisms.

Premature emergence has been found to be a localized effect at some operating nuclear power plants but has not been a problem and is not expected to be a problem.

Stimulation of nuisance organisms has been satisfactorily mitigated at the single nuclear power plant with a once-through cooling system where previously it was a problem. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem.

The five issues are consolidated to facilitate the environmental review process because they are all caused by thermal effects resulting from operation of a plant's cooling system. Previous license renewal reviews conducted by the NRC have shown that the previously described thermal issues have not been a problem at operating nuclear power plants and would not change during the license renewal term, and so no future impacts are anticipated.

(42) *Effects of Cooling Water Discharge on Dissolved Oxygen, Gas Supersaturation, and Eutrophication:* The final rule amends Table B–1 by consolidating three Category 1 issues, ''Eutrophication,'' ''Gas supersaturation (gas bubble disease),'' and ''Low dissolved oxygen in the discharge,'' each with an impact level of small, and names the consolidated issue, ''Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication.'' The consolidated issue is a Category 1 issue, with an impact level of small. The three issues are consolidated given their similar nature and to facilitate the environmental review process. The final rule further amends Table B–1 by removing the entries for ''Eutrophication,'' ''Gas supersaturation (gas bubble disease),'' and ''Low dissolved oxygen in the discharge,'' and, by adding an entry for ''Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication.'' The finding column entry for the new consolidated issue states,

Gas supersaturation was a concern at a small number of operating nuclear power plants with once-through cooling systems but has been mitigated. Low dissolved oxygen was a concern at one nuclear power plant with a once-through cooling system but has been mitigated. Eutrophication (nutrient loading) and resulting effects on chemical and biological oxygen demands have not been found to be a problem at operating nuclear power plants.

(43) *Effects of Non-Radiological Contaminants on Aquatic Organisms:* The final rule amends Table B–1 by renaming the issue ''Accumulation of contaminants in sediments or biota'' as ''Effects of non-radiological contaminants on aquatic organisms.'' The renamed issue remains a Category 1 issue with an impact level of small. The final rule further amends Table B–1 by replacing the finding column entry, which states,

Accumulation of contaminants has been a concern at a few nuclear power plants but has been satisfactorily mitigated by replacing copper alloy condenser tubes with those of another metal. It is not expected to be a problem during the license renewal term.

with the following:

Best management practices and discharge limitations of NPDES permits are expected to minimize the potential for impacts to aquatic resources during continued operations and refurbishment associated with license renewal. Accumulation of metal contaminants has been a concern at a few nuclear power plants, but has been satisfactorily mitigated by replacing copper alloy condenser tubes with those of another metal.

(44) *Exposure of Aquatic Organisms to Radionuclides:* The final rule amends Table B–1 by adding a new Category 1 issue, ''Exposure of Aquatic Organisms to Radionuclides,'' with an impact level of small. The finding column entry for this issue states,

Doses to aquatic organisms are expected to be well below exposure guidelines developed to protect these aquatic organisms.

The issue has been added to evaluate the potential impact of radionuclide discharges upon aquatic organisms, based on comments from members of the public and Federal and State agencies raised during the license renewal process for various plants.

The revised GEIS evaluates the potential impact of radionuclides on aquatic organisms at nuclear power plants from continued operations during the license renewal term. For the evaluation, site-specific radionuclide concentrations in environmental media (e.g., water, air, milk, crops, food products, sediment, and fish and other aquatic biota) were obtained from publicly available REMP annual reports from 15 nuclear power plants. The REMP is conducted at every NRC licensed nuclear power plant to assess the environmental impacts from plant operations. This is done by collecting samples of environmental media from areas surrounding the plant for analysis to measure the amount of radioactivity, if any, in the samples. The media samples reflect the radiation exposure pathways to the public from radioactive effluents released by the nuclear power plant and from background radiation (i.e., cosmic sources, naturally-occurring radioactive material, including radon and global fallout). These 15 plants were selected to represent sites that reported a range of radionuclide concentrations in the sample media and included both boiling water reactors and pressurized water reactors. Site-specific radionuclide concentrations in water and sediments, as reported in the plant's REMP reports, were used in the calculations. The calculated radiation dose rates to aquatic organisms, based on exposure to radioactivity in the environmental media, were compared against radiation-safety guidelines issued by DOE, IAEA, NCRP, and ICRP. The NRC concluded that the impacts of radionuclides on aquatic organisms from past and current normal operations are small for all nuclear power plants and should not change appreciably during the license renewal term.

(45) *Effects of Dredging on Aquatic Organisms:* The final rule amends Table B–1 by adding a new Category 1 issue, ''Effects of dredging on aquatic organisms,'' with an impact level of small, to evaluate the impacts of dredging on aquatic organisms. The finding column entry for this issue states,

Dredging at nuclear power plants is expected to occur infrequently, would be of relatively short duration, and would affect relatively small areas. Dredging is performed under permit from the U.S. Army Corps of Engineers, and possibly, from other State or local agencies.

Licensees conduct dredging to maintain intake and discharge structures at nuclear power plant facilities and in some cases, to maintain barge slips. Dredging may disturb or remove benthic communities. In general, maintenance dredging for nuclear power plant operations occur infrequently, is of relatively short duration, and affects relatively small areas. Dredging is performed under a permit issued by the U.S. Army Corps of Engineers and consequently, each dredging action is subject to a site-specific environmental review conducted by the Corps. Dredging activities may also require permits from various State or local agencies.

(46) *Water Use Conflicts with Aquatic Resources (Plants with Cooling Ponds or Cooling Towers using Makeup Water from a River):* The final rule amends Table B–1 by adding a new Category 2 issue, ''Water use conflicts with aquatic resources (plants with cooling ponds or cooling towers using makeup water from a river),'' with an impact level range of small to moderate, to evaluate water use conflicts with aquatic resources in stream communities. The 1996 GEIS already addresses the resource aspects of this issue, and 10 CFR 51.53(c)(3)(ii)(A) requires a plant-specific analysis of the impacts of surface water withdrawals from rivers for cooling pond or cooling tower makeup on stream (i.e., aquatic) ecological communities. However, this stand-alone issue was created to clearly separate out the related aspects and potential impacts on aquatic communities associated with surface water withdrawals from a river for consumptive cooling water uses.

The finding column entry for this issue states,

Impacts on aquatic resources in stream communities affected by water use conflicts could be of moderate significance in some situations.

Such impacts could occur when water that supports these resources is diminished because of decreased availability due to droughts; increased water demand for agricultural, municipal, or industrial usage; or a combination of these factors. The potential range of impact levels at plants, subject to license renewal, with cooling ponds or cooling towers using makeup water from a river cannot be generically determined. The NRC has also removed the term ''low flow'' from the title of this issue, as set forth in the proposed rule, and other related river flow issues in the final rule as previously discussed in this section (*see* Issue 17, ''Surface Water Use Conflicts (Plants with Cooling Ponds or Cooling Towers Using Makeup Water from a River)'').

(47) *Effects on Aquatic Resources (Non-Cooling System Impacts):* The final rule amends Table B–1 by renaming the ''Refurbishment'' issue as ''Effects on aquatic resources (non-cooling system impacts).'' [35] It remains a Category 1 issue with an impact level of small. The final rule further amends Table B–1 by replacing the finding column entry, which states,

During plant shutdown and refurbishment there will be negligible effects on aquatic biota because of a reduction of entrainment and impingement of organisms or a reduced release of chemicals.

with the following:

Licensee application of appropriate mitigation measures is expected to result in no more than small changes to aquatic communities from their current condition.

(48) *Impacts of Transmission Line Right-of-Way (ROW) Management on Aquatic Resources:* The final rule amends Table B–1 by adding a new Category 1 issue, ''Impacts of transmission line right-of-way (ROW) management on aquatic resources,'' with an impact level of small, to evaluate the impact of transmission line ROW management on aquatic resources during the license renewal term. The finding column entry for this issue states,

Licensee application of best management practices to ROW maintenance is expected to result in no more than small impacts to aquatic resources.

Impacts on aquatic resources from transmission line ROW maintenance could occur as a result of the direct disturbance of aquatic habitats, soil erosion, changes in water quality (from sedimentation and thermal effects), or inadvertent releases of chemical contaminants from herbicide use. As described in the revised GEIS, the NRC expects any impact on aquatic resources resulting from transmission line ROW maintenance to be small, short term, and localized for all plants because of licensee application of best management practices.

The final rule further amends Table B–1 by appending a footnote to the issue column entry for ''Impacts of Transmission Line Right-of-Way (ROW) Management on Aquatic Resources,'' concerning the extent to which transmission lines and their associated ROW have been analyzed under the revised GEIS. This footnote is the same one that was added to Issue 3, ''Offsite land use in transmission line right-of-ways (ROWs).'' See the description of the changes made by the final rule to Issue 3 for further explanation of this amendment.

(49) Losses from Predation, Parasitism, and Disease Among Organisms Exposed to Sublethal Stresses: There are no changes to this issue, and it remains a Category 1 issue, with an impact level of small.

Special Status Species and Habitats

(50) *Threatened, Endangered, and Protected Species and Essential Fish Habitat:* The final rule amends Table B–1 by renaming the issue ''Threatened or endangered species'' as ''Threatened, endangered, and protected species and essential fish habitat.'' The final rule expands the scope of the issue to include essential fish habitats protected under the Magnuson-Stevens Fishery Conservation and Management Act (MSA). The renamed and expanded issue is a Category 2 issue. The final rule further amends Table B–1 by replacing the finding column entry, which states,

Generally, plant refurbishment and continued operations are not expected to adversely affect threatened or endangered species. However, consultation with appropriate agencies would be needed at the time of license renewal to determine whether threatened or endangered species are present and whether they would be adversely affected. See § 51.53(c)(3)(ii)(E).

with the following:

The magnitude of impacts on threatened, endangered, and protected species, critical habitat, and essential fish habitat would depend on the occurrence of listed species and habitats and the effects of power plant systems on them. Consultation with appropriate agencies would be needed to determine whether special status species or habitats are present and whether they would be adversely affected by continued operations and refurbishment associated with license renewal.

The final rule also amends Table B–1 by removing the words ''SMALL, MODERATE, or LARGE'' from the finding column entry because the Endangered Species Act (ESA) requires other findings.[36] In complying with the ESA, the NRC determines whether the effects of continued nuclear power plant operations and refurbishment (1) would have no effect, (2) are not likely to adversely affect, (3) are likely to adversely affect, or (4) are likely to jeopardize the listed species or adversely modify the designated critical habitat of Federally listed species populations or their critical habitat during the license renewal term. For listed species where the NRC has found that its action is ''likely to adversely affect'' the species or habitat, the NRC may further characterize the effects as ''is [or is not] likely to jeopardize listed species or adversely modify designated critical habitat.''

Similarly, the MSA also requires other findings. In complying with the MSA, the NRC determines whether the effects

[35] The proposed rule had renamed this issue ''Refurbishment impacts on aquatic resources.'' (74 FR 38125, 38136; July 31, 2009).

[36] The proposed rule did not reflect this change (74 FR 38125, 38137; July 31, 2009).

of continued nuclear power plant operations and refurbishment associated with license renewal would have: (1) No adverse impact, (2) minimal adverse impact, or (3) substantial adverse impact to the essential habitat of federally managed fish populations during the license renewal term. Therefore, the NRC believes that reporting its ESA and MSA findings instead of the ''SMALL, MODERATE, or LARGE'' significance levels of impact will clarify the results.

Historic and Cultural Resources

(51) *Historic and Cultural Resources:* The final rule amends Table B–1 by renaming the issue ''Historic and archaeological resources'' as ''Historic and cultural resources.'' It remains a Category 2 issue. The final rule further amends Table B–1 by replacing the finding column entry, which states,

> Generally, plant refurbishment and continued operations are expected to have no more than small adverse impacts on historic and archaeological resources. However, the National Historic Preservation Act requires the Federal agency to consult with the State Historic Preservation Officer to determine whether there are properties present that require protection. See § 51.53(c)(3)(ii)(K).

with the following:

> Continued operations and refurbishment associated with license renewal are expected to have no more than small impacts on historic and cultural resources located onsite and in the transmission line ROW because most impacts could be mitigated by avoiding those resources. The National Historic Preservation Act (NHPA) requires the Federal agency to consult with the State Historic Preservation Officer (SHPO) and appropriate Native American Tribes to determine the potential effects on historic properties and mitigation, if necessary.

The final rule further amends Table B–1 by removing the words ''SMALL, MODERATE, or LARGE'' from the finding column entry [37] because the National Historic Preservation Act (NHPA) requires the NRC to determine whether historic properties are present on or near the project site, and if so, whether the license renewal decision would result in any adverse effect upon such properties. Thus, the NRC in its plant-specific environmental review makes the following determinations: no historic properties present; historic properties are present, but not adversely affected; or there is an adverse effect.

If continued operations and refurbishment associated with license renewal result in any adverse effects, the NHPA Section 106 process requires consultation with the requisite State Historic Preservation Officer (SHPO) and if appropriate, the requisite Tribal Historic Preservation Officer. The license renewal applicant is typically an active participant in such consultation, and the applicant may agree to commit to carrying out the appropriate mitigation measures. If an agreement is reached, the parties will execute a Memorandum of Agreement. Therefore, the NRC believes that reporting its NHPA findings in the plant-specific SEIS, instead of the ''SMALL, MODERATE, or LARGE'' significance levels of impact, will clarify the results.

Socioeconomics

(52) *Employment and Income, Recreation and Tourism:* The final rule amends Table B–1 by adding a new Category 1 issue, ''Employment and income, recreation and tourism,'' which includes the ''tourism and recreation'' portion of a current Table B–1 Category 1 issue, ''Public services: public safety, social services, and tourism and recreation.'' The issue has an impact level of small. The final rule consolidates the tourism and recreation portion with the new generic analysis to cover employment and income given the similar nature of these issues and to facilitate the environmental review process. The revised GEIS provides an analysis of this consolidated issue and concludes that the impacts are generic to all plants undergoing license renewal. The finding column entry for this issue states,

> Although most nuclear plants have large numbers of employees with higher than average wages and salaries, employment, income, recreation, and tourism impacts from continued operations and refurbishment associated with license renewal are expected to be small.

(53) *Tax Revenues:* The impact of changes to tax revenues was discussed in the 1996 GEIS, but was not listed in Table B–1. The final rule amends Table B–1 by adding a new Category 1 issue, ''Tax revenues,'' to evaluate the impacts of license renewal on tax revenues. The issue has an impact level of small. The finding column entry for this issue states,

> Nuclear plants provide tax revenue to local jurisdictions in the form of property tax payments, payments in lieu of tax (PILOT), or tax payments on energy production. The amount of tax revenue paid during the license renewal term as a result of continued operations and refurbishment associated with license renewal is not expected to change.

Refurbishment activities, such as steam generator and vessel head replacement, have not had a noticeable effect on the value of nuclear power plants, thus changes in tax revenues are not anticipated from future refurbishment activities. Refurbishment activities involve the one-for-one replacement of existing components and are generally not considered a taxable improvement. Also, new property tax assessments; proprietary payments in lieu of tax stipulations, settlements, and agreements; and State tax laws are continually changing the amounts paid to taxing jurisdictions by nuclear power plant owners, and these occur independent of license renewal and refurbishment activities.

(54) *Community Services and Education:* The final rule amends Table B–1 by reclassifying two Category 2 issues, ''Public services: public utilities,'' with an impact level range of small to moderate, and ''Public services, education (refurbishment),'' with an impact level range of small to large, as Category 1 issues. The final rule consolidates these two issues with the Category 1 issue, ''Public services, education (license renewal term),'' which has an impact level of small, and the ''Public safety and social service'' portion of the Category 1 issue, ''Public services: public safety, social services, and tourism and recreation,'' which also has an impact level of small.[38] The final rule names the consolidated issue, ''Community services and education,'' and classifies it as a Category 1 issue with an impact level of small. The final rule further amends Table B–1 by removing the entries for ''Public services: public utilities,'' ''Public services, education (refurbishment),'' ''Public services, education (license renewal term),'' and ''Public services: public safety, social services, and tourism and recreation,'' and by adding the entry for ''Community services and education.'' The finding column entry for the ''Community services and education'' issue states,

> Changes resulting from continued operations and refurbishment associated with license renewal to local community and educational services would be small. With little or no change in employment at the licensee's plant, value of the power plant, payments on energy production, and PILOT payments expected during the license renewal term, community and educational services would not be affected by continued power plant operations.

The four issues are consolidated because all public services are equally affected by changes in plant operations and refurbishment associated with

[37] The proposed rule did not reflect this change (74 FR 38125, 38137; July 31, 2009).

[38] The ''tourism and recreation'' portion of the ''Public services: public safety, social services, and tourism and recreation'' issue was consolidated with the new generic analysis concerning employment and income to form the consolidated Category 1 issue, ''Employment and income, recreation and tourism'' (see Issue 52).

license renewal. Any changes in the number of workers at a nuclear power plant will affect demand for public services from local communities. Nevertheless, past environmental reviews conducted by the NRC since the issuance of the 1996 GEIS have shown that the number of workers at relicensed nuclear power plants has not changed significantly because of license renewal. Thus, no significant impacts on community services are anticipated from future license renewals. In addition, refurbishment activities, such as steam generator and vessel head replacement, have not required the large numbers of workers and the months of time that was conservatively analyzed in the 1996 GEIS, and as such, significant impacts on community services are no longer anticipated. Combining the four issues also facilitates the environmental review process.

(55) *Population and Housing:* The final rule amends Table B–1 by renaming the Category 2 issue, ''Housing impacts,'' with an impact level range of small to large, to ''Population and housing.'' The final rule reclassifies this issue as a Category 1 issue with an impact level of small. As described in the revised GEIS, the availability and value of housing are directly affected by changes in population. The final rule further amends Table B–1 by removing the entry for ''Housing impacts,'' and by adding an entry for ''Population and housing.'' The finding column entry for this issue states,

Changes resulting from continued operations and refurbishment associated with license renewal to regional population and housing availability and value would be small. With little or no change in employment at the licensee's plant expected during the license renewal term, population and housing availability and values would not be affected by continued power plant operations.

As described in the revised GEIS, the NRC has determined that the impacts of continued operations and refurbishment activities on population and housing during the license renewal term would be small. Moreover, any impacts are not dependent on the socioeconomic setting of the nuclear power plant and are generic to all plants.

(56) *Transportation:* The final rule amends Table B–1 by reclassifying the Category 2 issue, ''Public services, Transportation,'' with an impact level range of small to large, as a Category 1 issue with an impact level of small, and renaming it ''Transportation.'' The final rule further amends Table B–1 by replacing the finding column entry, which states,

Transportation impacts (level of service) of highway traffic generated during plant refurbishment and during the term of the renewed license are generally expected to be of small significance. However, the increase in traffic associated with additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites. See § 51.53(c)(3)(ii)(J).

with the following:

Changes resulting from continued operations and refurbishment associated with license renewal to traffic volumes would be small.

As described in the revised GEIS, the NRC has determined that the numbers of workers have not changed significantly due to license renewal, so transportation impacts from continued operations and refurbishment associated with license renewal are no longer expected to be significant.

Human Health

(57) *Radiation Exposures to the Public:* The final rule amends Table B–1 by consolidating two Category 1 issues, ''Radiation exposures to the public during refurbishment'' and ''Radiation exposure to public (license renewal term)'' and names the consolidated issue, ''Radiation exposures to the public.'' The consolidated issue is a Category 1 issue with an impact level of small. These issues are consolidated given their similar nature and to facilitate the environmental review process. The final rule amends Table B–1 by removing the entries for ''Radiation exposures to the public during refurbishment'' and ''Radiation exposure to public (license renewal term)'' and by adding an entry for ''Radiation exposures to the public.'' The finding column entry for this consolidated issue states,

Radiation doses to the public from continued operations and refurbishment associated with license renewal are expected to continue at current levels, and would be well below regulatory limits.

(58) *Radiation Exposures to Plant Workers:* The final rule amends Table B–1 by consolidating two Category 1 issues, ''Occupational radiation exposures during refurbishment'' and ''Occupational radiation exposures (license renewal term)'' and names the consolidated issue, ''Radiation exposures to plant workers.'' The consolidated issue is a Category 1 issue with an impact level of small. These issues are consolidated given their similar nature and to facilitate the environmental review process. The final rule amends Table B–1 by removing the entries ''Occupational radiation exposures during refurbishment'' and ''Occupational radiation exposures (license renewal term)'' and by adding an entry for ''Radiation exposures to plant workers.'' The finding column entry for the combined issue states,

Occupational doses from continued operations and refurbishment associated with license renewal are expected to be within the range of doses experienced during the current license term and would continue to be well below regulatory limits.

(59) *Human Health Impact from Chemicals:* The final rule amends Table B–1 by adding a new Category 1 issue, ''Human health impact from chemicals,'' to evaluate the potential impacts to plant workers and members of the public from exposure to chemicals. The new issue has an impact level of small. The finding column entry for this issue states,

Chemical hazards to plant workers resulting from continued operations and refurbishment associated with license renewal are expected to be minimized by the licensee implementing good industrial hygiene practices as required by permits and Federal and State regulations. Chemical releases to the environment and the potential for impacts to the public are expected to be minimized by adherence to discharge limitations of NPDES and other permits.

The evaluation addresses the potential impact of chemicals on human health resulting from normal operations of a nuclear power plant during the license renewal term. Impacts of chemical exposure to human health are considered to be small if the use of chemicals within the plant is in accordance with industrial safety guides and discharges of chemicals to water bodies are within effluent limitations designed to ensure protection of water quality and aquatic life.

The disposal of hazardous chemicals used at nuclear power plants by licensees is subject to the RCRA and the CWA (which requires licensees to hold an NPDES permit). Adherence by the licensee to these statutory requirements should minimize adverse impacts to the environment, workers, and the public. It is anticipated that all plants would continue to operate in compliance with all applicable permits and that no mitigation measures beyond those implemented during the current license term would be warranted as a result of license renewal.

A review of the documents, as referenced in the revised GEIS, operating monitoring reports, and consultations with utilities and regulatory agencies that were performed for the 1996 GEIS, indicated that the effects of the discharge of chlorine and other biocides on water quality have been of small significance for all power plants. Small quantities of biocides are readily dissipated and/or are chemically altered in the body of water receiving them, so significant cumulative impacts to water quality would not be expected. The NRC expects no major changes in the operation of plant cooling systems during the license renewal term, so no changes are anticipated in the effects of biocide discharges on the quality of the receiving waters. The EPA and the States regulate discharges of sanitary wastes and heavy metals through NPDES permits. The NRC considers discharges that do not violate the permit limits to be of small significance. The effects of minor chemical discharges and spills on water quality are also expected to be of small significance during the license renewal term, and the appropriate regulating agencies would require the licensee to mitigate these discharges and spills as needed.

(60) *Microbiological Hazards to the Public (Plants with Cooling Ponds or Canals or Cooling Towers that Discharge to a River):* The final rule amends Table B–1 by renaming the ''Microbiological organisms (public health) (plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)'' issue as ''Microbiological hazards to the public (plants with cooling ponds or canals or cooling towers that discharge to a river).'' The issue remains a Category 2 issue, with an impact level range of small to large. The final rule further amends Table B–1 by replacing the finding column entry, which states,

These organisms are not expected to be a problem at most operating plants except possibly at plants using cooling ponds, lakes, or canals that discharge to small rivers. Without site-specific data, it is not possible to predict the effects generically. See § 51.53(c)(3)(ii)(G).

with the following:

These organisms are not expected to be a problem at most operating plants except possibly at plants using cooling ponds, lakes, or canals, or that discharge into rivers. Impacts would depend on site-specific characteristics.

(61) *Microbiological Hazards to Plant Workers:* The final rule amends Table B–1 by renaming the ''Microbiological organisms (occupational health)'' issue as ''Microbiological hazards to plant workers.'' It remains a Category 1 issue with an impact level of small. The final rule amends Table B–1 by adding the phrase ''as required by permits and Federal and State regulations'' to the end of the finding column entry.

(62) *Chronic Effects of Electromagnetic Fields (EMFs):* The final rule amends Table B–1 by renaming the ''Electromagnetic fields, chronic effects'' issue as ''Chronic effects of electromagnetic fields (EMFs).'' It remains an uncategorized issue with an impact level of uncertain because there is no national scientific consensus on the potential impacts from chronic exposure to EMFs. The final rule further amends Table B–1 by replacing the finding column entry, which states,

Biological and physical studies of 60-Hz electromagnetic fields have not found consistent evidence linking harmful effects with field exposures. However, research is continuing in this area and a consensus scientific view has not been reached.

with the following:

Studies of 60-Hz EMFs have not uncovered consistent evidence linking harmful effects with field exposures. EMFs are unlike other agents that have a toxic effect (e.g., toxic chemicals and ionizing radiation) in that dramatic acute effects cannot be forced and longer-term effects, if real, are subtle. Because the state of the science is currently inadequate, no generic conclusion on human health impacts is possible.

Although there is no conclusion as to the impact level, and this issue is not considered to be a Category 1 issue in the sense that a generic conclusion on the impact level has not been reached, this issue will be treated uniformly in plant-specific SEISs by essentially providing the discussion appearing in this issue's finding column entry in Table B–1 until a national scientific consensus has been reached.

The final rule further amends Table B–1 by appending a footnote to the issue column entry for ''Chronic Effects of Electromagnetic Fields (EMFs),'' concerning the extent to which transmission lines and their associated right of ways have been analyzed under the revised GEIS. This footnote is the same one that was added to Issue 3, ''Offsite land use in transmission line right-of-ways (ROWs).'' See the description of the changes made by the final rule to Issue 3 for further explanation of this amendment. In addition, the final rule retains the footnote that was appended to issue column entry but renumbers that footnote from ''5'' to ''6'' and retains the footnote that was appended to category column entry but renumbers that footnote from ''4'' to ''5.''

(63) *Physical Occupational Hazards:* The final rule amends Table B–1 by adding a new Category 1 issue, ''Physical occupational hazards,'' to evaluate the potential impact of physical occupational hazards on human health resulting from normal nuclear power plant operations during the license renewal term. The issue has an impact level of small. The finding column entry for this issue states,

Occupational safety and health hazards are generic to all types of electrical generating stations, including nuclear power plants, and are of small significance if the workers adhere to safety standards and use protective equipment as required by Federal and State regulations.

Through a Memorandum of Understanding (53 FR 43950; October 31, 1988) between the NRC and the Occupational Safety and Health Administration (OSHA), plant conditions that result in an occupational risk, but do not affect the safety of licensed radioactive materials, are under the statutory authority of OSHA rather than the NRC. Nevertheless, the impact of physical occupational hazards on human health has been raised by the public, as well as Federal and State agencies during the license renewal process. As such, this issue has been added to allow for a more complete analysis of the human health impact of continued power plant operation during the license renewal term. Occupational hazards can be minimized by licensees when workers adhere to safety standards and use appropriate protective equipment, although fatalities and injuries from accidents can still occur. Data for occupational injuries in 2005 obtained from the U.S. Bureau of Labor Statistics indicate that the rate of fatal injuries in the utility sector is less than the rate for many sectors (e.g., construction, transportation and warehousing, agriculture, forestry, fishing and hunting, wholesale trade, and mining) and that the incidence rate for nonfatal occupational injuries and illnesses is the least for electric power generation, followed by electric power transmission control and distribution. It is expected that over the license renewal term, licensees would ensure that their workers continue to adhere to safety standards and use protective equipment, so adverse occupational impacts would be of small significance at all sites.

(64) *Electric Shock Hazards:* The final rule amends Table B–1 by renaming the ''Electromagnetic fields, acute effects (electric shock)'' issue as ''Electric shock hazards.'' It remains a Category 2 issue with an impact level range of small to large. The final rule further amends Table B–1 by replacing the finding column entry, which states,

Electrical shock resulting from direct access to energized conductors or from induced charges in metallic structures have not been found to be a problem at most operating plants and generally are not expected to be a problem during the license renewal term. However, site-specific review is required to determine the significance of the electric shock potential at the site. See § 51.53(c)(3)(ii)(H).

with the following:

Electrical shock potential is of small significance for transmission lines that are operated in adherence with the National Electrical Safety Code (NESC). Without a review of conformance with NESC criteria of each nuclear power plant's in-scope transmission lines, it is not possible to generically determine the significance of the electrical shock potential.

The final rule's change to the finding column entry reflects the analysis in the revised GEIS concerning the potential of electrical shock from transmission lines. The final rule further amends Table B–1 by appending a footnote to the issue column entry for ''Electric shock hazards,'' concerning the extent to which transmission lines and their associated right of ways have been analyzed under the revised GEIS. This footnote is the same one that was added to Issue 3, ''Offsite land use in transmission line right-of-ways (ROWs).'' See the description of the changes made by the final rule to Issue 3 for further explanation of this amendment.

Postulated Accidents

(65) *Design-Basis Accidents and (66) Severe Accidents:* ''Design-basis accidents,'' and ''Severe accidents,'' with impact levels of small, remain Category 1 and 2 issues, respectively. The final rule amends Table B–1 by making minor clarifying changes to the finding column entries for both of these issues.

Environmental Justice

(67) *Minority and Low-Income Populations:* The final rule amends Table B–1 by adding a new Category 2 issue, ''Minority and low-income populations,'' to evaluate the impacts of continued operations and any refurbishment activities during the license renewal term on minority and low-income populations living in the vicinity of the plant. This issue was listed in Table B–1, prior to this final rule, but was not evaluated in the 1996 GEIS. In that table the finding column entry for this issue states, ''[t]he need for and the content of an analysis of environmental justice will be addressed in plant-specific reviews.''

Executive Order 12898 (59 FR 7629; February 16, 1994) initiated the Federal government's environmental justice program. The NRC's ''Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions'' (69 FR 52040; August 24, 2004) states, ''the NRC is committed to the general goals of E.O. 12898, [and] it will strive to meet those goals through its normal and traditional NEPA review process.'' Guidance for implementing E.O. 12898 was not available prior to the completion of the 1996 GEIS. By making this a Category 2 issue, the final rule requires license renewal applicants to identify, in their environmental reports, minority and low-income populations and communities residing in the vicinity of the nuclear power plant.

The final rule amends Table B–1 by replacing the finding column entry, which states,

The need for and the content of an analysis of environmental justice will be addressed in plant-specific reviews.

with the following:

Impacts to minority and low-income populations and subsistence consumption resulting from continued operations and refurbishment associated with license renewal will be addressed in plant-specific reviews. See NRC Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions (69 FR 52040; August 24, 2004).

The final rule does not adopt the proposed rule's impact range of small to moderate for this issue as E.O. 12898 requires a determination of whether human health and environmental effects of continued operations during the license renewal term and refurbishment associated with license renewal on minority and low-income populations would be disproportionately high and adverse. This determination will be made by the NRC in each plant-specific SEIS.

The final rule removes the footnote from the category column entry for this issue and removes footnote ''6'' from Table B–1 as footnote ''6'' is no longer necessary.

Waste Management

(68) *Low-Level Waste Storage and Disposal:* This issue remains a Category 1 issue with an impact level of small. The final rule amends Table B–1 by replacing the finding column entry, which states,

The comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts to the environment will remain small during the term of a renewed license. The maximum additional on-site land that may be required for low-level waste storage during the term of a renewed license and associated impacts will be small. Nonradiological impacts on air and water will be negligible. The radiological and nonradiological environmental impacts of long-term disposal of low-level waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient low-level waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

with the following:

The comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts to the environment would remain small during the license renewal term.

(69) *Onsite Storage of Spent Nuclear Fuel:* The final rule amends Table B–1 by renaming the ''Onsite spent fuel'' issue as ''Onsite storage of spent nuclear fuel.'' It remains a Category 1 issue with an impact level of small. As described in Section V, ''Related Issues of Importance,'' of this document, the final rule revises the finding column entry for this issue to reflect the D.C. Circuit's decision in *New York* v. *NRC* and the NRC's planned response thereto. Specifically, the final rule reduces the period of time covered by this issue from the period of extended license (from approval of the license renewal application to the expiration of the operating license) plus 30 years after the permanent shutdown of the reactor and expiration of the operating license to the period of extended license only. The final rule amends Table B–1 by replacing the finding column entry, which states,

The expected increase in the volume of spent fuel from an additional 20 years of operation can be safely accommodated on site with small environmental effects through dry or pool storage at all plants if a permanent repository or monitored retrievable storage is not available.

with the following:

The expected increase in the volume of spent fuel from an additional 20 years of operation can be safely accommodated onsite during the license renewal term with small environmental effects through dry or pool storage at all plants.

(70) *Offsite Radiological Impacts of Spent Nuclear Fuel and High-Level Waste Disposal:* The final rule amends Table B–1 by renaming the ''Offsite radiological impacts (spent fuel and high level waste disposal)'' issue as ''Offsite radiological impacts of spent nuclear fuel and high-level waste disposal.'' As described in Section V ''Related Issues of Importance,'' of this document, the final rule revises the finding column entry for this issue to reflect the D.C. Circuit's decision in *New York* v. *NRC* and the NRC's planned response thereto. Specifically, the final rule reclassifies this issue from Category

1, with no impact level assigned, to an uncategorized issue with an impact level of uncertain. The final rule removes the description in the finding column entry and replaces it with the following: ''Uncertain impact. The generic conclusion on offsite radiological impacts of spent nuclear fuel and high-level waste is not being finalized pending the completion of a generic environmental impact statement on waste confidence.'' Upon issuance of the generic EIS and revised Waste Confidence Rule, the NRC will make any necessary confirming amendments to this rule.

(71) *Mixed-Waste Storage and Disposal:* This issue remains a Category 1 issue with an impact level of small. The final rule amends Table B–1 by replacing the finding column entry for this issue, which states,

The comprehensive regulatory controls and the facilities and procedures that are in place ensure proper handling and storage, as well as negligible doses and exposure to toxic materials for the public and the environment at all plants. License renewal will not increase the small, continuing risk to human health and the environment posed by mixed waste at all plants. The radiological and nonradiological environmental impacts of long-term disposal of mixed waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient mixed waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

with the following:

The comprehensive regulatory controls and the facilities and procedures that are in place ensure proper handling and storage, as well as negligible doses and exposure to toxic materials for the public and the environment at all plants. License renewal would not increase the small, continuing risk to human health and the environment posed by mixed waste at all plants. The radiological and nonradiological environmental impacts of long-term disposal of mixed waste from any individual plant at licensed sites are small.

(72) *Nonradioactive Waste Storage and Disposal:* The final rule amends Table B–1 by renaming the issue ''Nonradiological waste'' as ''Nonradiological waste storage and disposal.'' It remains a Category 1 issue, with an impact level of small. The final rule further amends Table B–1 by replacing the finding column entry, which states,

No changes to generating systems are anticipated for license renewal. Facilities and procedures are in place to ensure continued proper handling and disposal at all sites.

with the following:

No changes to systems that generate nonradioactive waste are anticipated during the license renewal term. Facilities and procedures are in place to ensure continued proper handling, storage, and disposal, as well as negligible exposure to toxic materials for the public and the environment at all plants.

Cumulative Impacts

(73) *Cumulative Impacts:* The final rule amends Table B–1 by adding a new Category 2 issue, ''Cumulative impacts,'' to evaluate the potential cumulative impacts of license renewal. The term ''cumulative impacts'' is defined in 10 CFR 51.14(b) by reference to the CEQ regulations, 40 CFR 1508.7, as ''the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.''

For the purposes of analysis, past actions are considered to be when the nuclear power plant was licensed and constructed, present actions are related to current plant operations, and future actions are those that are reasonably foreseeable through the end of plant operations including the license renewal term. The geographic area over which past, present, and future actions are assessed depends on the affected resource.

The final rule requires license renewal applicants to identify other past, present, and reasonably foreseeable future actions, such as the construction and operation of other power plants and other industrial and commercial facilities in the vicinity of the nuclear power plant. The finding column entry for this issue states,

Cumulative impacts of continued operations and refurbishment associated with license renewal must be considered on a plant-specific basis. Impacts would depend on regional resource characteristics, the resource-specific impacts of license renewal, and the cumulative significance of other factors affecting the resource.

Uranium Fuel Cycle

(74) *Offsite Radiological Impacts—Individual Impacts from Other than the Disposal of Spent Fuel and High-Level Waste:* The final rule amends Table B–1 by renaming the ''Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high level waste)'' issue as ''Offsite radiological impacts—individual impacts from other than the disposal of spent fuel and high-level waste.'' This issue remains a Category 1 issue with an impact level of small. The final rule further amends Table B–1 by replacing the finding column entry, which states,

Off-site impacts of the uranium fuel cycle have been considered by the Commission in Table S–3 of this part. Based on information in the GEIS, impacts on individuals from radioactive gaseous and liquid releases including radon-222 and technetium-99 are small.

with the following:

The impacts to the public from radiological exposures have been considered by the Commission in Table S–3 of this part. Based on information in the GEIS, impacts to individuals from radioactive gaseous and liquid releases, including radon-222 and technetium-99, would remain at or below the NRC's regulatory limits.

(75) *Offsite Radiological Impacts—Collective Impacts from Other than the Disposal of Spent Fuel and High-Level Waste:* The final rule amends Table B–1 by renaming the ''Offsite radiological impacts (collective effects)'' issue as ''Offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste.'' It remains a Category 1 issue with no impact level assigned. The final rule further amends Table B–1 by replacing the finding column entry, which states,

The 100 year environmental dose commitment to the U.S. population from the fuel cycle, high level waste and spent fuel disposal excepted, is calculated to be about 14,800 person rem, or 12 cancer fatalities, for each additional 20-year power reactor operating term. Much of this, especially the contribution of radon releases from mines and tailing piles, consists of tiny doses summed over large populations. This same dose calculation can theoretically be extended to include many tiny doses over additional thousands of years as well as doses outside the U.S. The result of such a calculation would be thousands of cancer fatalities from the fuel cycle, but this result assumes that even tiny doses have some statistical adverse health effect which will not ever be mitigated (for example no cancer cure in the next thousand years), and that these doses projected over thousands of years are meaningful. However, these assumptions are questionable. In particular, science cannot rule out the possibility that there will be no cancer fatalities from these tiny doses. For perspective, the doses are very small fractions of regulatory limits, and even smaller fractions of natural background exposure to the same populations.

Nevertheless, despite all the uncertainty, some judgment as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgment in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the collective effects of the fuel cycle, this issue is considered Category 1.

with the following:

There are no regulatory limits applicable to collective doses to the general public from fuel-cycle facilities. The practice of estimating health effects on the basis of collective doses may not be meaningful. All fuel-cycle facilities are designed and operated to meet the applicable regulatory limits and standards. The Commission concludes that the collective impacts are acceptable.

The Commission concludes that the impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the collective impacts of the uranium fuel cycle, this issue is considered Category 1.

(76) *Nonradiological Impacts of the Uranium Fuel Cycle:* The final rule amends Table B–1 by making minor clarifying changes to the finding column entry for this issue. This issue remains a Category 1 issue with an impact level of small.

(77) *Transportation:* This issue remains a Category 1 issue with an impact level of small. The final rule amends Table B–1 by replacing the finding column entry for this issue, which states,

The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with average burnup for the peak rod to current levels approved by NRC up to 62,000 MWd/MTU and the cumulative impacts of transporting high-level waste to a single repository, such as Yucca Mountain, Nevada are found to be consistent with the impact values contained in 10 CFR 51.52(c), Summary Table S–4—Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor. If fuel enrichment or burnup conditions are not met, the applicant must submit an assessment of the implications for the environmental impact values reported in § 51.52.

with the following:

The impacts of transporting materials to and from uranium-fuel-cycle facilities on workers, the public, and the environment are expected to be small.

Termination of Nuclear Power Plant Operations and Decommissioning

(78) *Termination of Plant Operations and Decommissioning:* The final rule amends Table B–1 by consolidating a new Category 1 issue, ''Termination of nuclear power plant operations'' with six other Category 1 issues related to the decommissioning of a nuclear power plant: ''Radiation doses,'' ''Waste management,'' ''Air quality,'' ''Water quality,'' ''Ecological resources,'' and ''Socioeconomic impacts,'' each with an impact level of small. The final rule names the consolidated issue, ''Termination of plant operations and decommissioning.'' The consolidated issue is a Category 1 issue with an impact level of small.

The final rule further amends Table B–1 by removing the entries for ''Radiation doses,'' ''Waste management,'' ''Air quality,'' ''Water quality,'' ''Ecological resources,'' and ''Socioeconomic impacts,'' and, by adding an entry for ''Termination of plant operations and decommissioning.'' The finding column entry for the consolidated issue states,

License renewal is expected to have a negligible effect on the impacts of terminating operations and decommissioning on all resources.

The 1996 GEIS analysis indicates that the six decommissioning issues are expected to be small at all nuclear power plant sites. The new issue addresses the impacts from terminating nuclear power plant operations and plant decommissioning. Termination of nuclear power plant operations results in the cessation of many routine plant operations as well as a significant reduction in the plant's workforce. It is assumed that termination of plant operations would not lead to the immediate decommissioning and dismantlement of the reactor or other power plant infrastructure.

The final rule consolidates the six decommissioning issues and the termination of nuclear power plant operations issue into one Category 1 issue to facilitate the environmental review process. For further information about the environmental effects of decommissioning, see the ''2002 Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Regarding the Decommissioning of Nuclear Power Reactors,'' NUREG–0586.

IX. Section-by-Section Analysis

The following section-by-section analysis discusses the sections in 10 CFR part 51 that are being amended as a result of the final rule.

Section 51.53(c)(2)

The NRC is clarifying the required contents of the license renewal environmental report, which applicants must submit in accordance with 10 CFR 54.23, ''Contents of application—environmental information,'' by revising the second sentence in this subparagraph to read, ''This report must describe in detail the affected environment around the plant, the modifications directly affecting the environment or any plant effluents, and any planned refurbishment activities.''

Sections 51.53(c)(3)(ii)(A), (B), (C), and (E)

For those applicants seeking an initial license renewal and holding either an operating license, construction permit, or combined license as of June 30, 1995, the environmental report shall include the information required in 10 CFR 51.53(c)(2) but is not required to contain assessments of the environmental impacts of certain license renewal issues identified as Category 1 (generically analyzed) issues in Appendix B to Subpart A of 10 CFR part 51. The environmental report must contain analyses of the environmental impacts of the proposed action, including the impacts of refurbishment activities, if any, associated with license renewal and the impacts of operation during the renewal term, for those issues identified as Category 2 (plant-specific analysis required) issues in Appendix B to Subpart A of 10 CFR part 51 and must include consideration of alternatives for reducing adverse impacts of Category 2 issues. In addition, the environmental report must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware. The required analyses are listed in 10 CFR 51.53(c)(3)(ii)(A)–(P).

The final rule language for 10 CFR 51.53(c)(3)(ii)(A), (B), (C), (E), (F), (G), (I), (J), (K), and (N) consists of changes to conform to the final changes in Table B–1, which in turn, reflects the revised GEIS. The modified paragraphs more accurately reflect the specific information needed in the environmental report that will help the NRC conduct the environmental review of the proposed action.

Section 51.53(c)(3)(ii)(A) is revised to incorporate the findings of the revised GEIS and to require applicants to provide information in their environmental reports regarding water use conflicts encompassing water availability and competing water demands, and related impacts on stream (aquatic) and riparian (terrestrial) communities. The numerical definition for a low flow river has also been deleted requiring that applicants withdrawing makeup water for cooling towers or cooling ponds from any river provide a plant-specific assessment of water use conflicts in their environmental reports.

Section 51.53(c)(3)(ii)(B) is revised to replace ''heat shock'' with ''thermal changes'' to reflect the final changes in

Table B–1 as described earlier in this document under ''Aquatic Resources'' environmental impact Issue 39, ''Thermal impacts on aquatic organisms (plants with once-through cooling systems or cooling ponds).''

Section 51.53(c)(3)(ii)(C) is revised to delete the reference to ''Ranney wells'' to conform to the final changes made in the revised Table B–1.

Section 51.53(c)(3)(ii)(E) is revised to expressly include nuclear power plant continued operations within the scope of the impacts to be assessed by license renewal applicants. The paragraph is further revised to expand the scope of the provision to include all Federal wildlife protection laws and essential fish habitat under the MSA.

Section 51.53(c)(3)(ii)(F)

The final rule removes and reserves 10 CFR 51.53(c)(3)(ii)(F) because the final rule changes the Category 2 issue, ''Air quality during refurbishment (nonattainment and maintenance areas),'' to Category 1, ''Air quality impacts (all plants).''

Section 51.53(c)(3)(ii)(G)

The final rule language for 10 CFR 51.53(c)(3)(ii)(G) is revised to delete the numerical definition for a low flow river to conform to the final changes made in the revised Table B–1.

Section 51.53(c)(3)(ii)(I)

The final rule removes and reserves 10 CFR 51.53(c)(3)(ii)(I) because several Category 2 socioeconomic issues are reclassified as Category 1.

Section 51.53(c)(3)(ii)(J)

The final rule removes and reserves 10 CFR 51.53(c)(3)(ii)(J) because the final rule changes the Category 2 issue, ''Public services, Transportation,'' to Category 1, ''Transportation.''

Section 51.53(c)(3)(ii)(K)

The final rule language for 10 CFR 51.53(c)(3)(ii)(K) is revised to more accurately reflect the specific information needed in the environmental report that will help the NRC conduct the environmental review of the proposed action.

Section 51.53(c)(3)(ii)(N)

The final rule adds a new paragraph 10 CFR 51.53 (c)(3)(ii)(N) to require license renewal applicants to provide information on the general demographic composition of minority and low-income populations and communities (by race and ethnicity) residing in the immediate vicinity of the plant that could be affected by the renewal of the plant's operating license, including any planned refurbishment activities, and ongoing and future plant operations.

Section 51.53(c)(3)(ii)(O)

The final rule adds a new paragraph 10 CFR 51.53 (c)(3)(ii)(O) to require license renewal applicants to provide information about other past, present, and reasonably foreseeable future actions occurring in the vicinity of the nuclear power plant that may result in a cumulative effect.

Section 51.53(c)(3)(ii)(P)

The final rule adds a new paragraph 10 CFR 51.53 (c)(3)(ii)(P) to require the license renewal applicant to assess the impact of any documented inadvertent releases of radionuclides to groundwater. The assessment must include a description of any groundwater protection program used for the surveillance of piping and components containing radioactive liquids for which a pathway to groundwater may exist. The assessment must also include a description of any past inadvertent releases, including the projected impact to the environment (e.g., aquifers, rivers, lakes, ponds) during the license renewal term.

Section 51.71(d)

The final rule language for 10 CFR 51.71(d) is revised to make minor conforming changes to clarify the readability and to include the analysis of cumulative impacts. Cumulative impacts were not addressed in the 1996 GEIS, but are currently being evaluated by the NRC in plant-specific supplements to the GEIS. The NRC is modifying this paragraph to more accurately reflect the cumulative impacts analysis conducted for environmental reviews of the proposed action.

Section 51.95(c)

The final rule language revisions to the introductory text of 10 CFR 51.95(c) are administrative in nature and replace the reference to the 1996 GEIS for license renewal of nuclear power plants with a reference to the revised GEIS.

Section 51.95(c)(4)

The final rule removes the terms ''resolved Category 2 issues'' and ''open Category 2 issues'' from the second sentence of 10 CFR 51.95(c)(4), makes other clarifying changes to enhance the readability of the sentence, corrects a typographical error, and removes otherwise ambiguous or unnecessary language. The terms ''resolved Category 2 issues'' and ''open Category 2 issues'' are not defined nor used in 10 CFR part 51. In addition, the revised GEIS does not contain these terms nor does the NRC use these terms in SEISs. The only instance in past NRC practice in which an ''open'' or ''resolved'' Category 2 issue arises is for the Category 2 ''Severe accidents'' issue. The ''Severe accidents'' issue requires the preparation of a severe accident mitigation alternatives (SAMA) analysis as a prerequisite to license renewal. If a license renewal applicant had not yet performed a SAMA analysis for a given plant, then the issue would remain ''open'' pending the completion of a SAMA analysis. Some licensees, however, have already performed a SAMA analysis at some point. Thus, if a license renewal applicant had performed a SAMA analysis for a particular plant, then the issue would be considered ''resolved,'' and there would be no need to repeat a SAMA analysis as part of a license renewal application. As the finding column entry for ''Severe accidents'' already provides for a previously prepared SAMA analysis, and the ''open'' or ''resolved'' terminology is not used in connection with any other GEIS issue, there is no need to retain this language in the second sentence of 10 CFR 51.95(c)(4).

Table B–1

The final rule revises Table B–1 to follow the organizational format of the revised GEIS. Environmental issues in Table B–1 are arranged by resource area. The environmental impacts of license renewal activities, including plant operations and refurbishment along with replacement power alternatives, are addressed in each resource area. Table B–1 organizes environmental impact issues under the following resource areas: (1) Land use; (2) visual resources; (3) air quality; (4) noise; (5) geologic environment; (6) surface water resources; (7) groundwater resources; (8) terrestrial resources; (9) aquatic resources; (10) special status species and habitats; (11) historic and cultural resources; (12) socioeconomics; (13) human health; (14) postulated accidents; (15) environmental justice; (16) waste management; (17) cumulative impacts; (18) uranium fuel cycle; and (19) termination of nuclear power plant operations and decommissioning. Discussions of the environmental impact issues in each resource area and classification of issues into Category 1 or Category 2 are provided in Section VIII, ''Final Actions and Basis for Changes to Table B–1'' of this document. Additional changes to Table B–1 in the final rule were discussed previously in applicable resource areas in Section VIII. Footnote 1 was updated to reference the revised GEIS. A minor edit was made to footnote 2, clause (3), to improve clarity. Footnote 4 was added to define the in-scope electric transmission lines. Consequently, the previous footnotes 4 and 5 were renumbered as footnotes 5 and 6, respectively. The previous footnote 6 was deleted, as it is no longer needed.

X. Guidance Documents

In the Rules and Regulations section of this issue of the **Federal Register**, the NRC is providing notice of the availability of three additional documents related to this final rule: (1) A revised GEIS, NUREG–1437, ''Generic Environmental Impact statement for License Renewal of Nuclear Plants,'' Vol. 1, ''Main Report'' (ADAMS Accession No. ML13106A241); Vol. 2, ''Public Comments'' (ADAMS Accession No. ML13106A242); and Vol. 3, ''Appendices'' (ADAMS Acession No. ML13106A244); (2) Revision 1 of Environmental Standard Review Plan (ESRP), NUREG–1555, Supplement 1, ''Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal'' (ADAMS Acession No. ML13106A246); and (3) Revision 1 of Regulatory Guide 4.2, Supplement 1, ''Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications'' (ADAMS Acession No. ML13067A354).

The revised GEIS is intended to improve the efficiency of the license renewal process by (1) Providing an evaluation of the types of environmental impacts that may occur from renewing commercial nuclear power plant operating licenses, (2) identifying and assessing impacts that are expected to be generic (the same or similar) at all nuclear power plants (or plants with specific plant or site characteristics), and (3) defining the number and scope of environmental impact issues that need to be addressed in plant-specific supplemental EISs. The content of the revised GEIS is discussed further in Section III, ''Discussion,'' of this document.

Revision 1 of RG 4.2, Supplement 1, provides general procedures for the preparation of environmental reports, which are submitted as part of the license renewal application for a nuclear power plant in accordance with 10 CFR part 54. More specifically, this revised RG explains the criteria for addressing Category 2 issues in the environmental report as required by the revisions to 10 CFR part 51 under the final rule.

The revised ESRP provides guidance to the NRC staff on how to conduct a license renewal environmental review. The ESRP parallels the format in RG 4.2. The primary purpose of the ESRP is to ensure that these reviews focus on those environmental concerns associated with license renewal as described in 10 CFR part 51.

XI. Agreement State Compatibility

Under the ''Policy Statement on Adequacy and Compatibility of Agreement States Programs,'' approved by the Commission on June 20, 1997, and published in the **Federal Register** (62 FR 46517), this rule is classified as compatibility category ''NRC.'' Agreement State Compatibility is not required for Category ''NRC'' regulations. The NRC program elements in this category are those that relate directly to areas of regulation reserved to the NRC by the Atomic Energy Act of 1954, as amended, or the provisions of Title 10 of the CFR. Although an Agreement State may not adopt program elements reserved to the NRC, it may wish to inform its licensees of certain requirements via a mechanism that is consistent with the particular State's administrative procedure laws. Category ''NRC'' regulations do not confer regulatory authority on the State.

XII. Availability of Documents

The NRC is making the documents identified in the following table available to interested persons through one or more of the methods provided in the **ADDRESSES** section of this document.

Document	PDR	Web	ADAMS Accession No.
NUREG–1437, Revision 1, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants,'' Vol. 1, ''Main Report''.	X	X	ML13106A241
NUREG–1437, Revision 1, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants,'' Vol. 2, ''Public Comments''.	X	X	ML13106A242
NUREG–1437, Revision 1, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants,'' Vol. 3, ''Appendices''.	X	X	ML13106A244
Regulatory Guide 4.2, Supplement 1, Revision 1, ''Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications''.	X	X	ML13067A354
NUREG–1555, Supplement 1, Revision 1, ''Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal''.	X	X	ML13106A246
Regulatory Analysis for RIN 3150–AI42, Final Rulemaking Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses.	X	X	ML13029A471
OMB Supporting Statement for RIN 3150–AI42, Final Rulemaking Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses.	X	X	ML110760342
SECY–12–0063, Final Rule: Revisions to Environmental Protection Regulations for the Renewal of Nuclear Power Plant Operating Licenses (10 CFR part 50; RIN 3150–AI42) (April 20, 2012).	X	X	ML110760033
Staff Requirements Memorandum for SECY–12–0063 (December 6, 2012)	X	X	ML12341A134
Meeting Between the U.S. Nuclear Regulatory Commission and Public Stakeholders Concerning Implementation of Final Rule for Revisions to the Environmental Protection Regulations for the Renewal of Nuclear Power Plant Operating Licenses and Other License Renewal Environmental Review Issues (TAC No. ME2308) (July 21, 2011).	X	X	ML11182B535
Recommendations for Enhancing Reactor Safety in the 21st Century, The Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident'' (July 12, 2011).	X	X	ML111861807
NRC Press Release No. 10–060, ''NRC Asks National Academy of Sciences to Study Cancer Risk in Populations Living Near Nuclear Power Facilities'' (April 7, 2010).	X	X	ML100970142
Summary of Public Meetings to Discuss Proposed Rule Regarding Title 10, part 51 of the *Code of Federal Regulations* and the Draft Revision to the Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG–1437, Revision 1 (November 3, 2009).	X	X	ML093070141

Document	PDR	Web	ADAMS Accession No.
Official Transcript of Public Meeting to Discuss the Draft Generic Environmental Impact Statement, Dana Point, CA (October 22, 2009).	X	X	ML093100505
Official Transcript of Public Meeting to Discuss the Draft Generic Environmental Impact Statement, Pismo Beach, CA (October 20, 2009).	X	X	ML093070174
Official Transcript of Public Meeting to Discuss the Draft Generic Environmental Impact Statement, Rockville, MD (October 1, 2009).	X	X	ML092931678
Official Transcript of Public Meeting to Discuss the Draft Generic Environmental Impact Statement, Oak Brook, IL (September 24, 2009).	X	X	ML092931545
Official Transcript of Public Meeting to Discuss the Draft Generic Environmental Impact Statement, Newton, MA (September 17, 2009).	X	X	ML092931681
Official Transcript of Public Meeting to Discuss the Draft Generic Environmental Impact Statement, Atlanta, GA (September 15, 2009).	X	X	ML092810007
NRC Response to Public Comments Received on Proposed 10 CFR part 51 Rule, ''Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses'' (RIN 3150–AI42).	X	X	ML111450013
NRC Response to Public Comments Related to Draft Regulatory Guide, DG–4015 (Proposed Revision 1 of Regulatory Guide 4.2, Supplement 1)—''Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications'' (RIN 3150–AI42).	X	X	ML13067A355
Regulatory History for Proposed Rule, ''Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses'' (RIN 3150–AI42).	X	X	ML093160539
Draft NUREG–1437, Vols. 1 and 2, Revision 1—''Generic Environmental Impact Statement for License Renewal of Nuclear Plants''.	X	X	ML090220654
Draft Regulatory Guide, DG–4015 (Proposed Revision 1 of RG 4.2, Supplement 1), ''Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications''.	X	X	ML091620409
Draft NUREG–1555, Supplement 1, Revision 1—''Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal''.	X	X	ML090230497
NEI 07–07, ''Industry Ground Water Protection Initiative—Final Guidance Document''	X	X	ML072610036
Liquid Radioactive Release Lessons Learned Task Force Final Report (September 1, 2006).	X	X	ML062650312
NUREG–1437, Vol. 1, Addendum 1, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants,'' Main Report, Section 6.3—Transportation, Table 9.1, Summary of NEPA Issues for License Renewal of Nuclear Power Plants.	X	X	ML040690720
NUREG–1437, Vol. 1, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants,'' Main Report.	X	X	ML040690705
NUREG–1437, Vol. 2, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants,'' Appendices.	X	X	ML040690738

XIII. Voluntary Consensus Standards

The National Technology Transfer and Advancement Act of 1995, Public Law 104–113, requires that Federal agencies use technical standards that are developed or adopted by voluntary consensus standards bodies unless using such a standard is inconsistent with applicable law or is otherwise impractical. This final rulemaking, which amends various provisions of 10 CFR part 51, does not constitute the establishment of a standard that contains generally applicable requirements.

XIV. Environmental Impact—Categorical Exclusion

The NRC has determined that the promulgation of this final rule is a type of procedural action that meets the criteria of the categorical exclusion set forth in 10 CFR 51.22(c)(3)(i) and (iii). Therefore, neither an environmental impact statement nor an environmental assessment has been prepared for this final rule.

XV. Paperwork Reduction Act Statement

This final rule contains new or amended information collection requirements that are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501, *et seq.*). These requirements were approved by the Office of Management and Budget (OMB), control number 3150–0021.

The burden to the public for these information collections is estimated to be reduced by an average of 311.15 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the information collection. Send comments on any aspect of these information collections, including suggestions for reducing the burden, to the Information Services Branch (T–5 F53), U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001, or by email to *INFOCOLLECTS.RESOURCE@NRC.GOV;* and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB–10202, (3150–0021), Office of Management and Budget, Washington, DC 20503, or by email to *Chad_S._Whiteman@omb.eop.gov.*

Public Protection Notification

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.

XVI. Plain Writing

The Plain Writing Act of 2010 (Pub. L. 111–274) requires Federal agencies to write documents in a clear, concise, well-organized manner that also follows other best practices appropriate to the subject or field and the intended audience. The NRC has attempted to use plain language in promulgating this rule consistent with the Federal Plain Writing Act guidelines.

XVII. Regulatory Analysis

The NRC has prepared a regulatory analysis of this regulation. The analysis examines the costs and benefits of the alternatives considered by the NRC. Availability of the regulatory analysis is provided in Section XII, ''Availability of Documents,'' of this document.

XVIII. Regulatory Flexibility Act Certification

In accordance with the Regulatory Flexibility Act (5 U.S.C. 605(b)), the NRC certifies that this rule does not have a significant economic impact on a substantial number of small entities. The final rule affects only nuclear power plant licensees filing license renewal applications. The companies that own these plants do not fall within the scope of the definition of ''small entities'' set forth in the Regulatory Flexibility Act or the size standards established by the NRC (10 CFR 2.810).

XIX. Backfitting and Issue Finality

Issuance of this final rule does not constitute ''backfitting'' as defined in 10 CFR 50.109(a)(1) of the Backfit Rule and is not otherwise inconsistent with the applicable issue finality provisions in 10 CFR part 52. The final rule does not meet the definition of a backfit in 10 CFR 50.109(a)(1) because the document is not a ''modification of or addition to systems, structures, components, or design of a facility; or the design approval or manufacturing license for a facility; or the procedures or organization required to design, construct or operate a facility.'' For these reasons, issuance of this final rule does not constitute ''backfitting'' within the meaning of the definition of ''backfitting'' in 10 CFR 50.109(a)(1). Similarly, the issuance of the this final rule does not constitute an action inconsistent with any of the issue finality provisions in 10 CFR part 52.

XX. Congressional Review Act

In accordance with the Congressional Review Act of 1996, the NRC has determined that this action is not a major rule and has verified this determination with the Office of Information and Regulatory Affairs of the OMB.

List of Subjects in 10 CFR Part 51

Administrative practice and procedure, Environmental impact statement, Nuclear materials, Nuclear power plants and reactors, Reporting and recordkeeping requirements.

For the reasons set out in the preamble and under the authority of the Atomic Energy Act of 1954, as amended; the Energy Reorganization Act of 1974, as amended; and 5 U.S.C. 552 and 553; the NRC amends 10 CFR part 51 as follows:

Part 51—Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions

■ 1. The authority citation for part 51 is revised to read as follows:

Authority: Atomic Energy Act sec. 161, 1701 (42 U.S.C. 2201, 2297f); Energy Reorganization Act secs. 201, 202, 211 (42 U.S.C. 5841, 5842, 5851); Government Paperwork Elimination Act sec. 1704 (44 U.S.C. 3504 note). Subpart A also issued under National Environmental Policy Act secs. 102, 104, 105 (42 U.S.C. 4332, 4334, 4335); Pub. L. 95 604, Title II, 92 Stat. 3033 3041; Atomic Energy Act sec. 193 (42 U.S.C. 2243). Sections 51.20, 51.30, 51.60, 51.80. and 51.97 also issued under Nuclear Waste Policy Act secs. 135, 141, 148 (42 U.S.C. 10155, 10161, 10168). Section 51.22 also issued under Atomic Energy Act sec. 274 (42 U.S.C. 2021) and under Nuclear Waste Policy Act sec. 121 (42 U.S.C. 10141). Sections 51.43, 51.67, and 51.109 also issued under Nuclear Waste Policy Act sec. 114(f) (42 U.S.C. 10134(f)).

■ 2. Amend § 51.53 by:
■ a. Revising the second sentence of paragraph (c)(2);
■ b. Revising the first sentence of paragraph (c)(3)(ii)(A);
■ c. Revising the second sentence of paragraph (c)(3)(ii)(B);
■ d. Revising paragraph (c)(3)(ii)(C);
■ e. Revising paragraph (c)(3)(ii)(E);
■ f. Removing and reserving paragraph (c)(3)(ii)(F);
■ g. Revising paragraph (c)(3)(ii)(G);
■ h. Removing and reserving paragraphs (c)(3)(ii)(I) and (J);
■ i. Revising paragraph (c)(3)(ii)(K); and
■ j. Adding paragraphs (c)(3)(ii)(N), (O), and (P).

The revisions and additions read as follows:

§ 51.53 Postconstruction environmental reports.

* * * * *

(c) * * *

(2) * * * This report must describe in detail the affected environment around the plant, the modifications directly affecting the environment or any plant effluents, and any planned refurbishment activities. * * *

(3) * * *

(ii) * * *

(A) If the applicant's plant utilizes cooling towers or cooling ponds and withdraws makeup water from a river, an assessment of the impact of the proposed action on water availability and competing water demands, the flow of the river, and related impacts on stream (aquatic) and riparian (terrestrial) ecological communities must be provided. * * *

(B) * * * If the applicant cannot provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from thermal changes and impingement and entrainment.

(C) If the applicant's plant pumps more than 100 gallons (total onsite) of groundwater per minute, an assessment of the impact of the proposed action on groundwater must be provided.

* * * * *

(E) All license renewal applicants shall assess the impact of refurbishment, continued operations, and other license-renewal-related construction activities on important plant and animal habitats. Additionally, the applicant shall assess the impact of the proposed action on threatened or endangered species in accordance with Federal laws protecting wildlife, including but not limited to, the Endangered Species Act, and essential fish habitat in accordance with the Magnuson-Stevens Fishery Conservation and Management Act.

* * * * *

(G) If the applicant's plant uses a cooling pond, lake, or canal or discharges into a river, an assessment of the impact of the proposed action on public health from thermophilic organisms in the affected water must be provided.

* * * * *

(K) All applicants shall identify any potentially affected historic or archaeological properties and assess whether any of these properties will be affected by future plant operations and any planned refurbishment activities in accordance with the National Historic Preservation Act.

* * * * *

(N) Applicants shall provide information on the general demographic composition of minority and low-income populations and communities (by race and ethnicity) residing in the immediate vicinity of the plant that could be affected by the renewal of the plant's operating license, including any planned refurbishment activities, and ongoing and future plant operations.

(O) Applicants shall provide information about other past, present, and reasonably foreseeable future actions occurring in the vicinity of the nuclear plant that may result in a cumulative effect.

(P) An applicant shall assess the impact of any documented inadvertent releases of radionuclides into groundwater. The applicant shall include in its assessment a description of any groundwater protection program used for the surveillance of piping and components containing radioactive liquids for which a pathway to groundwater may exist. The assessment must also include a description of any past inadvertent releases and the projected impact to the environment (e.g., aquifers, rivers, lakes, ponds, ocean) during the license renewal term.

■ 3. In § 51.71, revise paragraph (d) to read as follows:

§ 51.71 Draft environmental impact statement—contents.

* * * * *

(d) *Analysis.* Unless excepted in this paragraph or § 51.75, the draft environmental impact statement will include a preliminary analysis that considers and weighs the environmental effects, including any cumulative effects, of the proposed action; the environmental impacts of alternatives to the proposed action; and alternatives available for reducing or avoiding adverse environmental effects. Additionally, the draft environmental impact statement will include a consideration of the economic, technical, and other benefits and costs of the proposed action and alternatives. The draft environmental impact statement will indicate what other interests and considerations of Federal policy, including factors not related to environmental quality, if applicable, are relevant to the consideration of environmental effects of the proposed action identified under paragraph (a) of this section. The draft supplemental environmental impact statement prepared at the license renewal stage under § 51.95(c) need not discuss the economic or technical benefits and costs of either the proposed action or alternatives except if benefits and costs are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation. In addition, the supplemental environmental impact statement prepared at the license renewal stage need not discuss other issues not related to the environmental effects of the proposed action and associated alternatives. The draft supplemental environmental impact statement for license renewal prepared under § 51.95(c) will rely on conclusions as amplified by the supporting information in the GEIS for issues designated as Category 1 in appendix B to subpart A of this part. The draft supplemental environmental impact statement must contain an analysis of those issues identified as Category 2 in appendix B to subpart A of this part that are open for the proposed action. The analysis for all draft environmental impact statements will, to the fullest extent practicable, quantify the various factors considered. To the extent that there are important qualitative considerations or factors that cannot be quantified, these considerations or factors will be discussed in qualitative terms. Consideration will be given to compliance with environmental quality standards and requirements that have been imposed by Federal, State, regional, and local agencies having responsibility for environmental protection, including applicable zoning and land-use regulations and water pollution limitations or requirements issued or imposed under the Federal Water Pollution Control Act. The environmental impact of the proposed action will be considered in the analysis with respect to matters covered by environmental quality standards and requirements irrespective of whether a certification or license from the appropriate authority has been obtained. While satisfaction of Commission standards and criteria pertaining to radiological effects will be necessary to meet the licensing requirements of the Atomic Energy Act, the analysis will, for the purposes of NEPA, consider the radiological effects of the proposed action and alternatives.

* * * * *

Compliance with the environmental quality standards and requirements of the Federal Water Pollution Control Act (imposed by EPA or designated permitting states) is not a substitute for, and does not negate the requirement for NRC to weigh all environmental effects of the proposed action, including the degradation, if any, of water quality, and to consider alternatives to the proposed action that are available for reducing adverse effects. Where an environmental assessment of aquatic impact from plant discharges is available from the permitting authority, the NRC will consider the assessment in its determination of the magnitude of environmental impacts for striking an overall cost-benefit balance at the construction permit and operating license and early site permit and combined license stages, and in its determination of whether the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decision-makers would be unreasonable at the license renewal stage. When no such assessment of aquatic impacts is available from the permitting authority, NRC will establish on its own, or in conjunction with the permitting authority and other agencies having relevant expertise, the magnitude of potential impacts for striking an overall cost-benefit balance for the facility at the construction permit and operating license and early site permit and combined license stages, and in its determination of whether the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decision-makers would be unreasonable at the license renewal stage.

* * * * *

■ 4. Amend § 51.95 by revising paragraph (c) introductory text and the second sentence of paragraph (c)(4) to read as follows:

§ 51.95 Postconstruction environmental impact statements.

* * * * *

(c) *Operating license renewal stage.* In connection with the renewal of an operating license or combined license for a nuclear power plant under 10 CFR parts 52 or 54 of this chapter, the Commission shall prepare an environmental impact statement, which is a supplement to the Commission's NUREG–1437, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants'' (June 2013), which is available in the NRC's Public Document Room, 11555 Rockville Pike, Rockville, Maryland 20852.

* * * * *

(4) * * * In order to make recommendations and reach a final decision on the proposed action, the NRC staff, adjudicatory officers, and Commission shall integrate the conclusions in the generic environmental impact statement for issues designated as Category 1 with information developed for those Category 2 issues applicable to the plant under § 51.53(c)(3)(ii) and any new and significant information. * * *

* * * * *

■ 5. In appendix B to subpart A of part 51, Table B–1 is revised to read as follows:

Appendix B to Subpart A—Environmental Effect of Renewing the Operating License of a Nuclear Power Plant

* * * * *

TABLE B–1—SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS [1]

Issue	Category [2]	Finding [3]
Land Use		
Onsite land use	1	SMALL. Changes in onsite land use from continued operations and refurbishment associated with license renewal would be a small fraction of the nuclear power plant site and would involve only land that is controlled by the licensee.
Offsite land use	1	SMALL. Offsite land use would not be affected by continued operations and refurbishment associated with license renewal.
Offsite land use in transmission line right-of-ways (ROWs) [4].	1	SMALL. Use of transmission line ROWs from continued operations and refurbishment associated with license renewal would continue with no change in land use restrictions.
Visual Resources		
Aesthetic impacts	1	SMALL. No important changes to the visual appearance of plant structures or transmission lines are expected from continued operations and refurbishment associated with license renewal.
Air Quality		
Air quality impacts (all plants)	1	SMALL. Air quality impacts from continued operations and refurbishment associated with license renewal are expected to be small at all plants. Emissions resulting from refurbishment activities at locations in or near air quality nonattainment or maintenance areas would be short-lived and would cease after these refurbishment activities are completed. Operating experience has shown that the scale of refurbishment activities has not resulted in exceedance of the *de minimis* thresholds for criteria pollutants, and best management practices including fugitive dust controls and the imposition of permit conditions in State and local air emissions permits would ensure conformance with applicable State or Tribal Implementation Plans. Emissions from emergency diesel generators and fire pumps and routine operations of boilers used for space heating would not be a concern, even for plants located in or adjacent to nonattainment areas. Impacts from cooling tower particulate emissions even under the worst-case situations have been small.
Air quality effects of transmission lines [4]	1	SMALL. Production of ozone and oxides of nitrogen is insignificant and does not contribute measurably to ambient levels of these gases.
Noise		
Noise impacts	1	SMALL. Noise levels would remain below regulatory guidelines for offsite receptors during continued operations and refurbishment associated with license renewal.
Geologic Environment		
Geology and soils	1	SMALL. The effect of geologic and soil conditions on plant operations and the impact of continued operations and refurbishment activities on geology and soils would be small for all nuclear power plants and would not change appreciably during the license renewal term.
Surface Water Resources		
Surface water use and quality (non-cooling system impacts).	1	SMALL. Impacts are expected to be small if best management practices are employed to control soil erosion and spills. Surface water use associated with continued operations and refurbishment associated with license renewal would not increase significantly or would be reduced if refurbishment occurs during a plant outage.
Altered current patterns at intake and discharge structures.	1	SMALL. Altered current patterns would be limited to the area in the vicinity of the intake and discharge structures. These impacts have been small at operating nuclear power plants.
Altered salinity gradients	1	SMALL. Effects on salinity gradients would be limited to the area in the vicinity of the intake and discharge structures. These impacts have been small at operating nuclear power plants.
Altered thermal stratification of lakes	1	SMALL. Effects on thermal stratification would be limited to the area in the vicinity of the intake and discharge structures. These impacts have been small at operating nuclear power plants.
Scouring caused by discharged cooling water.	1	SMALL. Scouring effects would be limited to the area in the vicinity of the intake and discharge structures. These impacts have been small at operating nuclear power plants.
Discharge of metals in cooling system effluent.	1	SMALL. Discharges of metals have not been found to be a problem at operating nuclear power plants with cooling-tower-based heat dissipation systems and have been satisfactorily mitigated at other plants. Discharges are monitored and controlled as part of the National Pollutant Discharge Elimination System (NPDES) permit process.

TABLE B–1—SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS [1]—Continued

Issue	Category [2]	Finding [3]
Discharge of biocides, sanitary wastes, and minor chemical spills.	1	SMALL. The effects of these discharges are regulated by Federal and State environmental agencies. Discharges are monitored and controlled as part of the NPDES permit process. These impacts have been small at operating nuclear power plants.
Surface water use conflicts (plants with once-through cooling systems).	1	SMALL. These conflicts have not been found to be a problem at operating nuclear power plants with once-through heat dissipation systems.
Surface water use conflicts (plants with cooling ponds or cooling towers using makeup water from a river).	2	SMALL or MODERATE. Impacts could be of small or moderate significance, depending on makeup water requirements, water availability, and competing water demands.
Effects of dredging on surface water quality.	1	SMALL. Dredging to remove accumulated sediments in the vicinity of intake and discharge structures and to maintain barge shipping has not been found to be a problem for surface water quality. Dredging is performed under permit from the U.S. Army Corps of Engineers, and possibly, from other State or local agencies.
Temperature effects on sediment transport capacity.	1	SMALL. These effects have not been found to be a problem at operating nuclear power plants and are not expected to be a problem.
Groundwater Resources		
Groundwater contamination and use (non-cooling system impacts).	1	SMALL. Extensive dewatering is not anticipated from continued operations and refurbishment associated with license renewal. Industrial practices involving the use of solvents, hydrocarbons, heavy metals, or other chemicals, and/or the use of wastewater ponds or lagoons have the potential to contaminate site groundwater, soil, and subsoil. Contamination is subject to State or Environmental Protection Agency regulated cleanup and monitoring programs. The application of best management practices for handling any materials produced or used during these activities would reduce impacts.
Groundwater use conflicts (plants that withdraw less than 100 gallons per minute [gpm]).	1	SMALL. Plants that withdraw less than 100 gpm are not expected to cause any groundwater use conflicts.
Groundwater use conflicts (plants that withdraw more than 100 gallons per minute [gpm]).	2	SMALL, MODERATE, or LARGE. Plants that withdraw more than 100 gpm could cause groundwater use conflicts with nearby groundwater users.
Groundwater use conflicts (plants with closed-cycle cooling systems that withdraw makeup water from a river).	2	SMALL, MODERATE, or LARGE. Water use conflicts could result from water withdrawals from rivers during low-flow conditions, which may affect aquifer recharge. The significance of impacts would depend on makeup water requirements, water availability, and competing water demands.
Groundwater quality degradation resulting from water withdrawals.	1	SMALL. Groundwater withdrawals at operating nuclear power plants would not contribute significantly to groundwater quality degradation.
Groundwater quality degradation (plants with cooling ponds in salt marshes).	1	SMALL. Sites with closed-cycle cooling ponds could degrade groundwater quality. However, groundwater in salt marshes is naturally brackish and thus, not potable. Consequently, the human use of such groundwater is limited to industrial purposes.
Groundwater quality degradation (plants with cooling ponds at inland sites).	2	SMALL, MODERATE, or LARGE. Inland sites with closed-cycle cooling ponds could degrade groundwater quality. The significance of the impact would depend on cooling pond water quality, site hydrogeologic conditions (including the interaction of surface water and groundwater), and the location, depth, and pump rate of water wells.
Radionuclides released to groundwater	2	SMALL or MODERATE. Leaks of radioactive liquids from plant components and pipes have occurred at numerous plants. Groundwater protection programs have been established at all operating nuclear power plants to minimize the potential impact from any inadvertent releases. The magnitude of impacts would depend on site-specific characteristics.
Terrestrial Resources		
Effects on terrestrial resources (non-cooling system impacts).	2	SMALL, MODERATE, or LARGE. Impacts resulting from continued operations and refurbishment associated with license renewal may affect terrestrial communities. Application of best management practices would reduce the potential for impacts. The magnitude of impacts would depend on the nature of the activity, the status of the resources that could be affected, and the effectiveness of mitigation.
Exposure of terrestrial organisms to radionuclides.	1	SMALL. Doses to terrestrial organisms from continued operations and refurbishment associated with license renewal are expected to be well below exposure guidelines developed to protect these organisms.
Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds).	1	SMALL. No adverse effects to terrestrial plants or animals have been reported as a result of increased water temperatures, fogging, humidity, or reduced habitat quality. Due to the low concentrations of contaminants in cooling system effluents, uptake and accumulation of contaminants in the tissues of wildlife exposed to the contaminated water or aquatic food sources are not expected to be significant issues.

TABLE B–1—SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS [1]—Continued

Issue	Category [2]	Finding [3]
Cooling tower impacts on vegetation (plants with cooling towers).	1	SMALL. Impacts from salt drift, icing, fogging, or increased humidity associated with cooling tower operation have the potential to affect adjacent vegetation, but these impacts have been small at operating nuclear power plants and are not expected to change over the license renewal term.
Bird collisions with plant structures and transmission lines [4].	1	SMALL. Bird collisions with cooling towers and other plant structures and transmission lines occur at rates that are unlikely to affect local or migratory populations and the rates are not expected to change.
Water use conflicts with terrestrial resources (plants with cooling ponds or cooling towers using makeup water from a river).	2	SMALL or MODERATE. Impacts on terrestrial resources in riparian communities affected by water use conflicts could be of moderate significance.
Transmission line right-of-way (ROW) management impacts on terrestrial resources [4].	1	SMALL. Continued ROW management during the license renewal term is expected to keep terrestrial communities in their current condition. Application of best management practices would reduce the potential for impacts.
Electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock) [4].	1	SMALL. No significant impacts of electromagnetic fields on terrestrial flora and fauna have been identified. Such effects are not expected to be a problem during the license renewal term.
Aquatic Resources		
Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds).	2	SMALL, MODERATE, or LARGE. The impacts of impingement and entrainment are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems, depending on cooling system withdrawal rates and volumes and the aquatic resources at the site.
Impingement and entrainment of aquatic organisms (plants with cooling towers).	1	SMALL. Impingement and entrainment rates are lower at plants that use closed-cycle cooling with cooling towers because the rates and volumes of water withdrawal needed for makeup are minimized.
Entrainment of phytoplankton and zooplankton (all plants).	1	SMALL. Entrainment of phytoplankton and zooplankton has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Thermal impacts on aquatic organisms (plants with once-through cooling systems or cooling ponds).	2	SMALL, MODERATE, or LARGE. Most of the effects associated with thermal discharges are localized and are not expected to affect overall stability of populations or resources. The magnitude of impacts, however, would depend on site-specific thermal plume characteristics and the nature of aquatic resources in the area.
Thermal impacts on aquatic organisms (plants with cooling towers).	1	SMALL. Thermal effects associated with plants that use cooling towers are expected to be small because of the reduced amount of heated discharge.
Infrequently reported thermal impacts (all plants).	1	SMALL. Continued operations during the license renewal term are expected to have small thermal impacts with respect to the following: Cold shock has been satisfactorily mitigated at operating nuclear plants with once-through cooling systems, has not endangered fish populations or been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds, and is not expected to be a problem. Thermal plumes have not been found to be a problem at operating nuclear power plants and are not expected to be a problem. Thermal discharge may have localized effects but is not expected to affect the larger geographical distribution of aquatic organisms. Premature emergence has been found to be a localized effect at some operating nuclear power plants but has not been a problem and is not expected to be a problem. Stimulation of nuisance organisms has been satisfactorily mitigated at the single nuclear power plant with a once-through cooling system where previously it was a problem. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem.
Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication.	1	SMALL. Gas supersaturation was a concern at a small number of operating nuclear power plants with once-through cooling systems but has been mitigated. Low dissolved oxygen was a concern at one nuclear power plant with a once-through cooling system but has been mitigated. Eutrophication (nutrient loading) and resulting effects on chemical and biological oxygen demands have not been found to be a problem at operating nuclear power plants.
Effects of non-radiological contaminants on aquatic organisms.	1	SMALL. Best management practices and discharge limitations of NPDES permits are expected to minimize the potential for impacts to aquatic resources during continued operations and refurbishment associated with license renewal. Accumulation of metal contaminants has been a concern at a few nuclear power plants but has been satisfactorily mitigated by replacing copper alloy condenser tubes with those of another metal.
Exposure of aquatic organisms to radionuclides.	1	SMALL. Doses to aquatic organisms are expected to be well below exposure guidelines developed to protect these aquatic organisms.

TABLE B–1—SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS [1]—Continued

Issue	Category [2]	Finding [3]
Effects of dredging on aquatic organisms	1	SMALL. Dredging at nuclear power plants is expected to occur infrequently, would be of relatively short duration, and would affect relatively small areas. Dredging is performed under permit from the U.S. Army Corps of Engineers, and possibly, from other State or local agencies.
Water use conflicts with aquatic resources (plants with cooling ponds or cooling towers using makeup water from a river).	2	SMALL or MODERATE. Impacts on aquatic resources in stream communities affected by water use conflicts could be of moderate significance in some situations.
Effects on aquatic resources (non-cooling system impacts).	1	SMALL. Licensee application of appropriate mitigation measures is expected to result in no more than small changes to aquatic communities from their current condition.
Impacts of transmission line right-of-way (ROW) management on aquatic resources [4].	1	SMALL. Licensee application of best management practices to ROW maintenance is expected to result in no more than small impacts to aquatic resources.
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses.	1	SMALL. These types of losses have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Special Status Species and Habitats		
Threatened, endangered, and protected species and essential fish habitat.	2	The magnitude of impacts on threatened, endangered, and protected species, critical habitat, and essential fish habitat would depend on the occurrence of listed species and habitats and the effects of power plant systems on them. Consultation with appropriate agencies would be needed to determine whether special status species or habitats are present and whether they would be adversely affected by continued operations and refurbishment associated with license renewal.
Historic and Cultural Resources		
Historic and cultural resources [4]	2	Continued operations and refurbishment associated with license renewal are expected to have no more than small impacts on historic and cultural resources located onsite and in the transmission line ROW because most impacts could be mitigated by avoiding those resources. The National Historic Preservation Act (NHPA) requires the Federal agency to consult with the State Historic Preservation Officer (SHPO) and appropriate Native American Tribes to determine the potential effects on historic properties and mitigation, if necessary.
Socioeconomics		
Employment and income, recreation and tourism.	1	SMALL. Although most nuclear plants have large numbers of employees with higher than average wages and salaries, employment, income, recreation, and tourism impacts from continued operations and refurbishment associated with license renewal are expected to be small.
Tax revenues	1	SMALL. Nuclear plants provide tax revenue to local jurisdictions in the form of property tax payments, payments in lieu of tax (PILOT), or tax payments on energy production. The amount of tax revenue paid during the license renewal term as a result of continued operations and refurbishment associated with license renewal is not expected to change.
Community services and education	1	SMALL. Changes resulting from continued operations and refurbishment associated with license renewal to local community and educational services would be small. With little or no change in employment at the licensee's plant, value of the power plant, payments on energy production, and PILOT payments expected during the license renewal term, community and educational services would not be affected by continued power plant operations.
Population and housing	1	SMALL. Changes resulting from continued operations and refurbishment associated with license renewal to regional population and housing availability and value would be small. With little or no change in employment at the licensee's plant expected during the license renewal term, population and housing availability and values would not be affected by continued power plant operations.
Transportation	1	SMALL. Changes resulting from continued operations and refurbishment associated with license renewal to traffic volumes would be small.
Human Health		
Radiation exposures to the public	1	SMALL. Radiation doses to the public from continued operations and refurbishment associated with license renewal are expected to continue at current levels, and would be well below regulatory limits.
Radiation exposures to plant workers	1	SMALL. Occupational doses from continued operations and refurbishment associated with license renewal are expected to be within the range of doses experienced during the current license term, and would continue to be well below regulatory limits.

TABLE B–1—SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS [1]—Continued

Issue	Category [2]	Finding [3]
Human health impact from chemicals	1	SMALL. Chemical hazards to plant workers resulting from continued operations and refurbishment associated with license renewal are expected to be minimized by the licensee implementing good industrial hygiene practices as required by permits and Federal and State regulations. Chemical releases to the environment and the potential for impacts to the public are expected to be minimized by adherence to discharge limitations of NPDES and other permits.
Microbiological hazards to the public (plants with cooling ponds or canals or cooling towers that discharge to a river).	2	SMALL, MODERATE, or LARGE. These organisms are not expected to be a problem at most operating plants except possibly at plants using cooling ponds, lakes, or canals, or that discharge into rivers. Impacts would depend on site-specific characteristics.
Microbiological hazards to plant workers	1	SMALL. Occupational health impacts are expected to be controlled by continued application of accepted industrial hygiene practices to minimize worker exposures as required by permits and Federal and State regulations.
Chronic effects of electromagnetic fields (EMFs) [4,6].	N/A [5]	Uncertain impact. Studies of 60-Hz EMFs have not uncovered consistent evidence linking harmful effects with field exposures. EMFs are unlike other agents that have a toxic effect (e.g., toxic chemicals and ionizing radiation) in that dramatic acute effects cannot be forced and longer-term effects, if real, are subtle. Because the state of the science is currently inadequate, no generic conclusion on human health impacts is possible.
Physical occupational hazards	1	SMALL. Occupational safety and health hazards are generic to all types of electrical generating stations, including nuclear power plants, and are of small significance if the workers adhere to safety standards and use protective equipment as required by Federal and State regulations.
Electric shock hazards [4]	2	SMALL, MODERATE, or LARGE. Electrical shock potential is of small significance for transmission lines that are operated in adherence with the National Electrical Safety Code (NESC). Without a review of conformance with NESC criteria of each nuclear power plant's in-scope transmission lines, it is not possible to determine the significance of the electrical shock potential.
		Postulated Accidents
Design-basis accidents	1	SMALL. The NRC staff has concluded that the environmental impacts of design-basis accidents are of small significance for all plants.
Severe accidents	2	SMALL. The probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives.
		Environmental Justice
Minority and low-income populations	2	Impacts to minority and low-income populations and subsistence consumption resulting from continued operations and refurbishment associated with license renewal will be addressed in plant-specific reviews. See NRC Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions (69 FR 52040; August 24, 2004).
		Waste Management
Low-level waste storage and disposal	1	SMALL. The comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts to the environment would remain small during the license renewal term.
Onsite storage of spent nuclear fuel	1	SMALL. The expected increase in the volume of spent fuel from an additional 20 years of operation can be safely accommodated onsite during the license renewal term with small environmental effects through dry or pool storage at all plants.
Offsite radiological impacts of spent nuclear fuel and high-level waste disposal.	N/A [5]	Uncertain impact. The generic conclusion on offsite radiological impacts of spent nuclear fuel and high-level waste is not being finalized pending the completion of a generic environmental impact statement on waste confidence.[7]
Mixed-waste storage and disposal	1	SMALL. The comprehensive regulatory controls and the facilities and procedures that are in place ensure proper handling and storage, as well as negligible doses and exposure to toxic materials for the public and the environment at all plants. License renewal would not increase the small, continuing risk to human health and the environment posed by mixed waste at all plants. The radiological and nonradiological environmental impacts of long-term disposal of mixed waste from any individual plant at licensed sites are small.
Nonradioactive waste storage and disposal	1	SMALL. No changes to systems that generate nonradioactive waste are anticipated during the license renewal term. Facilities and procedures are in place to ensure continued proper handling, storage, and disposal, as well as negligible exposure to toxic materials for the public and the environment at all plants.

TABLE B–1—SUMMARY OF FINDINGS ON NEPA ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS [1]—Continued

Issue	Category [2]	Finding [3]
Cumulative Impacts		
Cumulative impacts	2	Cumulative impacts of continued operations and refurbishment associated with license renewal must be considered on a plant-specific basis. Impacts would depend on regional resource characteristics, the resource-specific impacts of license renewal, and the cumulative significance of other factors affecting the resource.
Uranium Fuel Cycle		
Offsite radiological impacts—individual impacts from other than the disposal of spent fuel and high-level waste.	1	SMALL. The impacts to the public from radiological exposures have been considered by the Commission in Table S–3 of this part. Based on information in the GEIS, impacts to individuals from radioactive gaseous and liquid releases, including radon-222 and technetium-99, would remain at or below the NRC's regulatory limits.
Offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste.	1	There are no regulatory limits applicable to collective doses to the general public from fuel-cycle facilities. The practice of estimating health effects on the basis of collective doses may not be meaningful. All fuel-cycle facilities are designed and operated to meet the applicable regulatory limits and standards. The Commission concludes that the collective impacts are acceptable. The Commission concludes that the impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the collective impacts of the uranium fuel cycle, this issue is considered Category 1.
Nonradiological impacts of the uranium fuel cycle.	1	SMALL. The nonradiological impacts of the uranium fuel cycle resulting from the renewal of an operating license for any plant would be small.
Transportation	1	SMALL. The impacts of transporting materials to and from uranium-fuel-cycle facilities on workers, the public, and the environment are expected to be small.
Termination of Nuclear Power Plant Operations and Decommissioning		
Termination of plant operations and decommissioning.	1	SMALL. License renewal is expected to have a negligible effect on the impacts of terminating operations and decommissioning on all resources.

[1] Data supporting this table are contained in NUREG–1437, Revision 1, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants'' (June 2013).

[2] The numerical entries in this column are based on the following category definitions:

Category 1: For the issue, the analysis reported in the Generic Environmental Impact Statement has shown:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic;

(2) A single significance level (i.e., small, moderate, or large) has been assigned to the impacts (except for Offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste); and

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

The generic analysis of the issue may be adopted in each plant-specific review.

Category 2: For the issue, the analysis reported in the Generic Environmental Impact Statement has shown that one or more of the criteria of Category 1 cannot be met, and therefore additional plant-specific review is required.

[3] The impact findings in this column are based on the definitions of three significance levels. Unless the significance level is identified as beneficial, the impact is adverse, or in the case of ''small,'' may be negligible. The definitions of significance follow:

SMALL—For the issue, environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered small as the term is used in this table.

MODERATE—For the issue, environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

LARGE—For the issue, environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

For issues where probability is a key consideration (i.e., accident consequences), probability was a factor in determining significance.

[4] This issue applies only to the in-scope portion of electric power transmission lines, which are defined as transmission lines that connect the nuclear power plant to the substation where electricity is fed into the regional power distribution system and transmission lines that supply power to the nuclear plant from the grid.

[5] NA (not applicable). The categorization and impact finding definitions do not apply to these issues.

[6] If, in the future, the Commission finds that, contrary to current indications, a consensus has been reached by appropriate Federal health agencies that there are adverse health effects from electromagnetic fields, the Commission will require applicants to submit plant-specific reviews of these health effects as part of their license renewal applications. Until such time, applicants for license renewal are not required to submit information on this issue.

[7] As a result of the decision of United States Court of Appeals in *New York* v. *NRC,* 681 F.3d 471 (DC Cir. 2012), the NRC cannot rely upon its Waste Confidence Decision and Rule until it has taken those actions that will address the deficiencies identified by the D.C. Circuit. Although the Waste Confidence Decision and Rule did not assess the impacts associated with disposal of spent nuclear fuel and high-level waste in a repository, it did reflect the Commission's confidence, at the time, in the technical feasibility of a repository and when that repository could have been expected to become available. Without the analysis in the Waste Confidence Decision and Rule regarding the technical feasibility and availability of a repository, the NRC cannot assess how long the spent fuel will need to be stored onsite.

TECHNICAL MEMORANDUM

From: Peter F. Andersen and James L. Ross, Tetra Tech

To: Rory Rahming, Florida Power & Light Company

Date: May 9, 2014

Subject: Evaluation of Required Floridan Water for Salinity Reduction in the Cooling Canal System

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Introduction

This technical memorandum describes the water and salt balance modeling of the proposed salinity reduction in the Florida Power & Light (FPL) Cooling Canal System (CCS), located at the Turkey Point Nuclear Power Plant. The modeling was conducted to provide an assessment of the volume of Floridan water that would be required to add to the CCS in order to reduce the hypersalinity of CCS water to salt concentrations commensurate with seawater.

Two spreadsheet-based water and salt balance models were employed for this analysis: 1) a steady state balance model based on long-term average flows to/from the CCS, and 2) a transient balance model calibrated to 22 months of hydrologic and water quality data collected as a part of FPL comprehensive pre-uprate monitoring (Ecology and Environment, 2012). These models were collectively used to provide estimates of the amount of Floridan water required to achieve the desired CCS salinity reductions and the corresponding changes to canal stage within the CCS.

Background

The CCS is a constructed surface water body that receives heated water from Turkey Point Nuclear Units 3 and 4. As the heated water travels southward along the discharge canals and northward back to the plant along return canals, it is cooled by evaporation and mixing with inflowing water from the Biscayne Aquifer. Due to the evaporative process, which is facilitated by the elevated temperature of the water, a portion of the water from the CCS is lost to the atmosphere, leaving dissolved solids behind in the CCS and producing hypersaline conditions in the CCS. Hypersaline water exhibits salinities greater than that of seawater, which has a salinity of approximately 35 g/L. Salinity in the CCS has ranged between 42 and 69 g/L over the past 10 years.

In order to mitigate the contribution of hypersaline water to the underlying Biscayne Aquifer, FPL has evaluated remedial alternatives to reduce the salinity of water in the CCS to seawater levels. In the course of that evaluation, an inspection of 22 months of pre-uprate monitoring data revealed a correlation between daily rainfall on the CCS and CCS salinity, where rainfall events were generally followed by short term reductions in CCS salinity. The visual comparison between daily precipitation and daily averaged CCS salinities in Figure 1 illustrates this relationship. Two phenomena are evident in this figure: 1) CCS salinities generally reduce during rainy months (June through September); 2) significant rainfall events produce notable reductions in CCS salinity. The latter phenomenon is effectively illustrated by a large (> 7 inches) rainfall event in late-September 2010 that induced an approximate 10 g/L drop in the average CCS salinity.

Because precipitation events are simply freshwater inflows to the CCS, they effectively dilute the water and reduce salinity. Based on the effectiveness of these freshwater inflows in reducing salinity, a remedial alternative was proposed wherein low salinity water would be added to the CCS on a sustained basis. The Floridan Aquifer was identified as the source of added water due to the low salinity and long term availability of groundwater.

Balance Modeling

In order to evaluate the effectiveness of reducing CCS salinity with added Floridan water, as well as the associated volume of water that would be needed, two balance models were employed. First, a simple, uncalibrated water and salt balance model of the CCS was developed. This balance model is based on a conceptual understanding of the inflows to and outflows from the CCS; it was employed as a screening model to provide a broad assessment of the efficacy of the proposed remedial alternative.

Subsequent to analysis with the steady state balance model, a transient water and salt balance model of the CCS system was configured to provide estimates of impacts to the CCS caused by the remedial alternative, including canal stage changes, changes in salinity, and time required to reduce salinity to the desired concentration. This transient model, which has been accepted by South Florida Water Management District, is calibrated to 22 months of CCS hydrologic and water quality data, such that it effectively replicates historical responses of the CCS to changes in inflows and outflow; as such, this transient model is capable of evaluating a wide range of climatic and operational conditions.

Steady State Balance Model

In order to determine the volume of Floridan water required to reduce CCS salinity to approximately 35 g/L, a steady state water and salt balance model of the CCS was developed. This balance model was based on a conceptual model of CCS equilibrium where inflows to the CCS are equal to and offset by outflows from the CCS, such that the volume of water in the CCS is invariant. The components of inflow are:

- Inflow from Nuclear Units 3 and 4,
- Precipitation,
- Seepage of groundwater, and
- Blowdown from other nuclear units.

Outflows from the CCS are comprised of:

- Outflow to nuclear Units 3 and 4 (assumed equal to the inflow from these units),
- Evaporation, and
- Seepage to groundwater.

Based on measurements and estimates of many of the flow components and associated salinities, the steady state water and salt balance effectively defines equilibrium flows into and out of the CCS, as well as the resulting salinity of the water within the CCS (Table 1a).

An additional inflow component was considered in the balance model with an assumed concentration of approximate 2 g/L, based on recent measurements of Floridan water. Using the balance model, the volume of the additional inflow was adjusted until the equilibrium concentration of CCS water reached approximately 35 g/L; the minimum additional inflow was derived to be 14 million gallons per day (mgd), which reduced the CCS salinity to 34.4 g/L (Table 1b).

Transient Balance Model

As a necessary component of FPL's pre-uprate monitoring, a transient water and salt balance model was constructed for the CCS and calibrated to 22-months of hydrologic and salinity data from September 2010 through May 2012 (Ecology and Environment, 2012). Though the model considers the same CCS inflows and outflows as the steady state model, it calculates these inflows and outflows on a daily basis using 15-minute water level, salinity, and meteorological data measured throughout the Biscayne Aquifer, Biscayne Bay, the CCS, and nearby canals. The model uses these daily inflows and outflows to effectively simulate daily changes in CCS water and salt storage. The quality of the model is illustrated by the accurate simulation of daily changes in average CCS water levels and salinity between over the 22-month period (Figure 1). It should be noted that the model correctly simulates the reduction in salinity resulting from the addition of precipitation. The ability to match the response of salinity to addition of a known quantity and quality of water provides confidence that the model is capable of predicting a similar cause and response situation with the addition of Floridan water.

Transiently modeling the impacts of the proposed remedial alternative was a two-step process, wherein two predictive versions of the transient balance model were configured. The first model configuration, called the *unconstrained* model, predicted water levels in the CCS considering the addition of 14 mgd of Floridan water. This model was used to determine the increase in canal stage that would likely result from the added inflow: an average of 0.25 ft due to the Floridan-based inflow. Salinity changes were not assessed with this model due to the compounding error associated with predicting both hydrologic and water quality data.

The second model configuration, referred to as the *constrained* model, added the calculated 0.25 ft stage increase to the 22 months of observed CCS stages, and predicted the change in CCS salinity likely to result from the contribution of low salinity (2 g/L) Floridan water to the CCS. This model predicted a 41.3% reduction in CCS salinity from 60 g/L to approximately 35 g/L within 1 year of the initiation of the remedial action (Figure 2). Figure 2 also suggests that the quantity of added Floridan water could be optimally managed to obtain CCS salinities that are close to seawater. Note that less than 14 mgd may be required during the wet season while more may be required during the dry season when less precipitation is being added naturally.

The estimated flow of water for salinity reduction (14 mgd) appears low relative to the volume of the CCS (approximately 4.2×10^9 gallons); the key to remedial success, however, is the significantly low salinity in the Floridan relative to the salinity observed in the CCS. This difference between Floridan and CCS salinities may become less pronounced over time as the quality of the Floridan aquifer will likely vary and may degrade with continued stress on the aquifer. As such, two additional evaluations were performed with the transient model in order to determine the requisite increases in Floridan-based inflows to the CCS should the associated salinity increase by 50% (3 g/L) and 100% (4 g/L). Based on these analyses, it was determined that:

- If Floridan water were to degrade to 3 g/L, 14.5 mgd would be required to reduce the CCS salinity to 35.2 g/L; and
- If Floridan water were to degrade to 4 g/L, 15 mgd would be required to reduce the CCS salinity to 35.3 g/L.

As in the base remediation scenario, the relative difference between the CCS and the Floridan aquifer groundwater is critical to successful salinity reduction.

Summary

Changes in salinity in the CCS appear to be strongly correlated to precipitation: large precipitation events are followed by appreciable reductions in the salinity of the CCS. This observation led to exploration of the effect of adding on a continuous basis a source of water with a much lower salinity than the CCS. A simple steady state water balance and a more complex transient water balance were used in this evaluation. In order to abate the hypersaline conditions within the CCS, water and salt balance modeling determined that an average 14 mgd of Floridan water with a salinity of 2 g/L would need to be added to the CCS. Both models estimated that the addition of the Floridan water would reduce CCS concentrations to approximately 35 g/L. The transient model indicates that reduction of CCS salinity to that of seawater will take less than one year using an average addition of 14 mgd. Sensitivity analysis on the salinity of the added water indicates that the required quantities to reduce CCS concentration to approximately 35 g/L are 14.5 and 15 mgd for assumed Floridan aquifer salinities of 3 and 4 g/L, respectively. The transient model also indicates that the added water will raise the average stage in the CCS by 0.25 ft. This rise is accounted for in the water balance that is used for computations of CCS salinity and water budget components.

References

Ecology and Environment, 2012, Turkey Point Plan Comprehensive Pre-Uprate Monitoring Report: Unit 3 & 4 Uprate Project, Prepared for Florida Power & Light, October 2012.

Table 1a. Steady State Water and Salt Balance Model for the CCS (Base Case)

Inflows	Flow (mgd)	Salinity (g/L)
Precipitation	24.7	0
Blowdown	7.9	7
Groundwater Inflow to CCS	35.9	40
Total Inflow	68.5	

Outflows	Flow (mgd)	Salinity (g/L)
Evaporation	43.7	0
Seepage to Groundwater from CCS	24.8	60
Total Outflow	68.5	
	CCS Salinity (g/L):	**60**

Table 1b. Steady State Water and Salt Balance Model for the CCS (with Added Floridan Water)

Inflows	Flow (mgd)	Salinity (g/L)
Precipitation	24.7	0
Blowdown	7.9	7
Added Water	14	2
Groundwater Inflow to CCS	28.9	35
Total Inflow	75.5	

Outflows	Flow (mgd)	Salinity (g/L)
Evaporation	43.7	0
Seepage to Groundwater from CCS	31.8	34.4
Total Outflow	75.5	
	CCS Salinity (g/L):	**34.4**

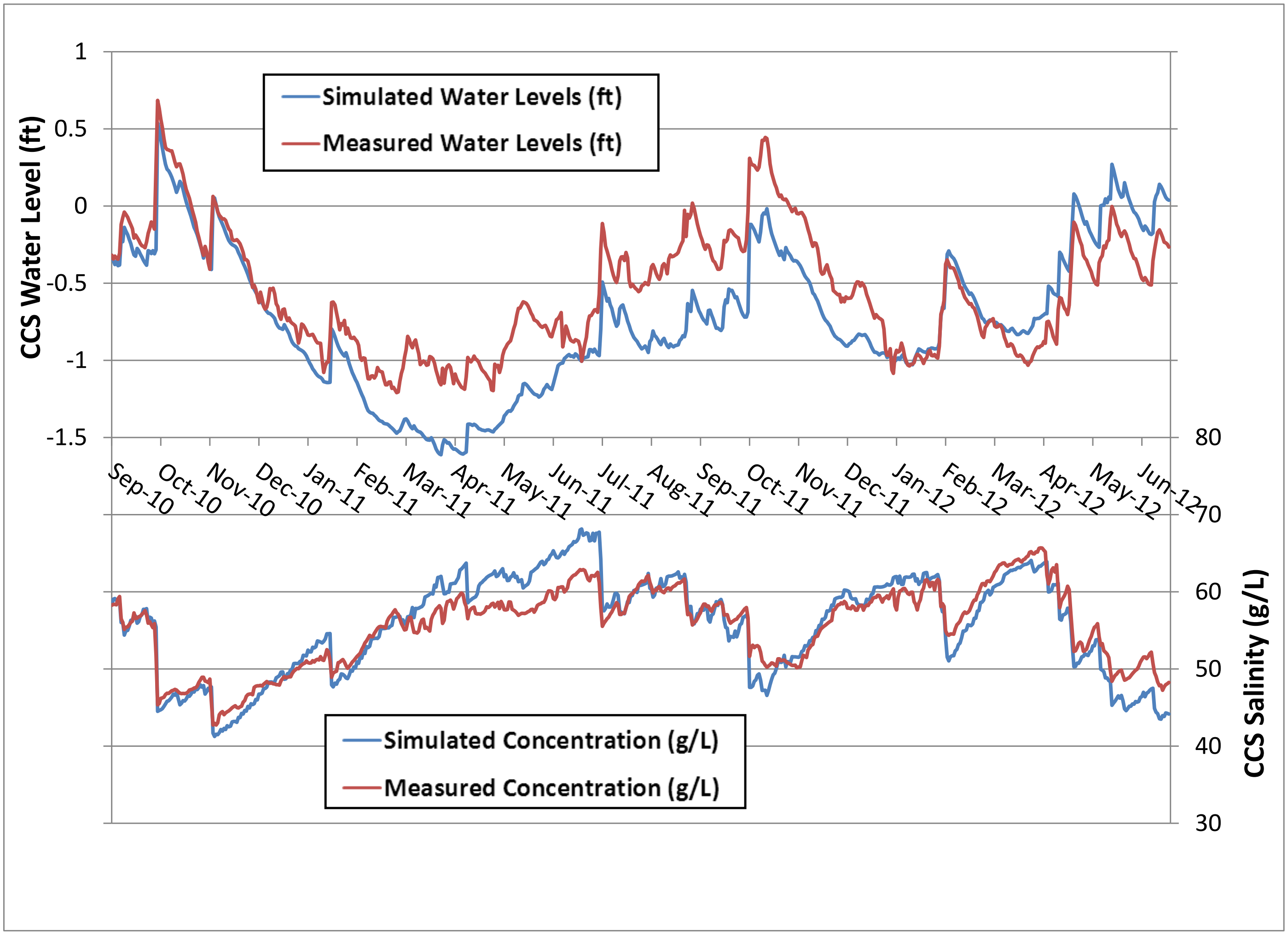


Figure 1. Comparison of observed daily average CCS water levels and salinity to those simulated by the calibrated 22-month transient water and salt balance model

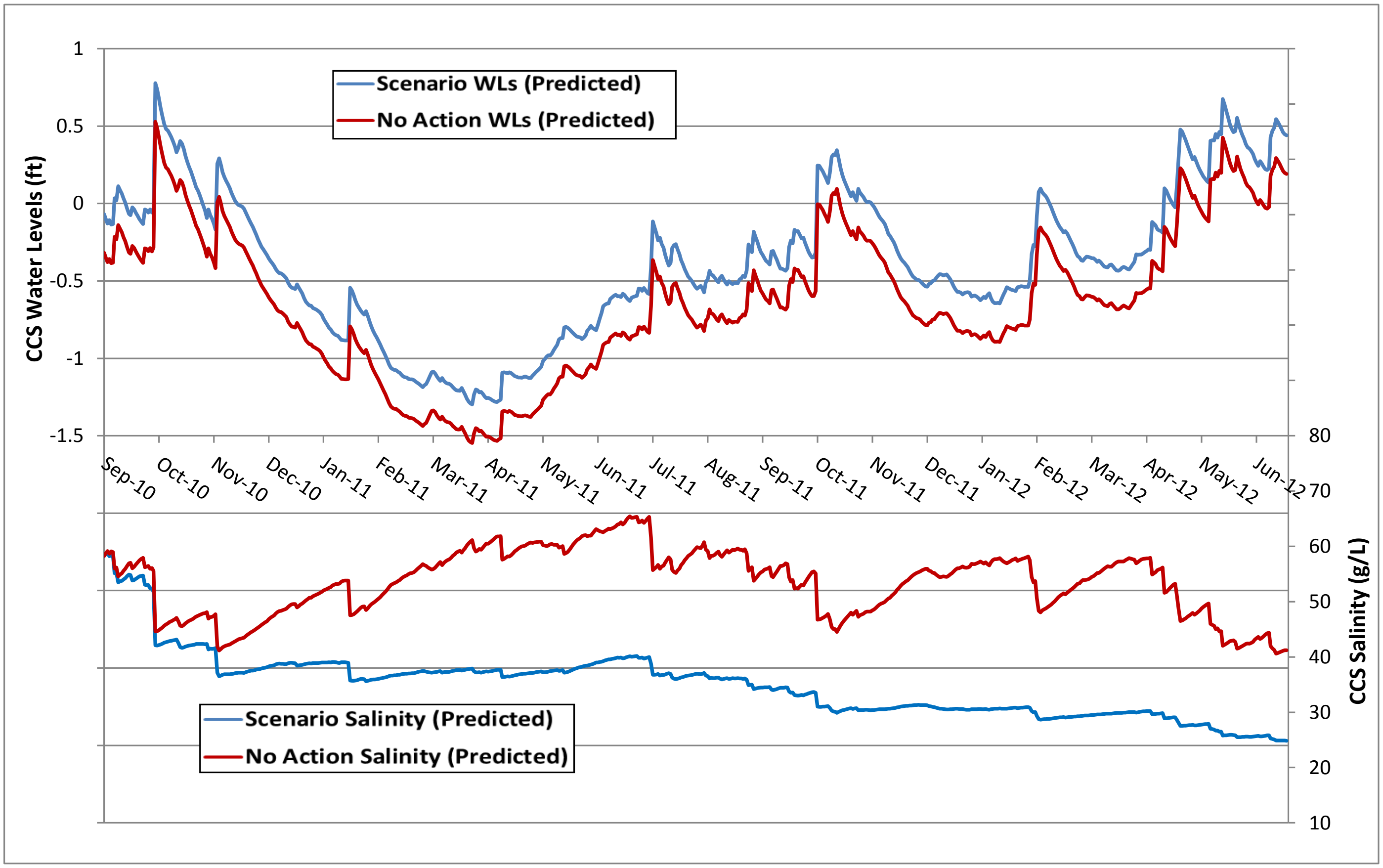


Figure 2. Predicted CCS stage and salinity in response to the additional inflow of Floridan water at a rate of 14 mgd and salinity of 2 g/L

BEFORE THE STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

STATE OF FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION	)	IN THE OFFICE OF THE SOUTHEAST DISTRICT
v.	)	
	)	OGC FILE NO. 16-0241
FLORIDA POWER & LIGHT COMPANY,	)	

CONSENT ORDER

This Consent Order ("Order") is entered into between the State of Florida Department of Environmental Protection ("Department") and Florida Power & Light Company ("Respondent" or "FPL") to reach settlement of certain matters at issue between the Department and Respondent.

The Department finds:

1. The Department is the administrative agency of the State of Florida having the power and duty to protect Florida's air and water resources and to administer and enforce the provisions of Chapter 403, Florida Statutes ("F.S."), and the rules promulgated and authorized in Title 62, Florida Administrative Code ("F.A.C."). The Department has jurisdiction over the matters addressed in this Order.

2. FPL is a "person" as defined under Section 403.031(5), F.S.

3. FPL owns and operates a cooling canal system ("CCS"), an approximately 5,900-acre network of unlined canals at Turkey Point Power Plant. FPL began construction of the CCS in 1972. Turkey Point originally obtained cooling water for the facility by drawing surface water from an intake channel connected to Biscayne Bay, and discharging that water, after it had been heated, into Biscayne Bay and Card Sound through a series of discharge canals. In 1971, FPL entered into a Final Judgment with the U.S. Department of Justice that required the permitting, construction, operation, and maintenance of a closed-loop cooling canal configuration with limitations on makeup and blowdown water.

4. FPL is the permittee and operates the CCS under National Pollutant Discharge Elimination System/Industrial Wastewater Permit Number FL0001562 (the "Permit"). This Permit is issued pursuant to the federal NPDES program and Florida industrial wastewater permitting program. The Permit authorizes wastewater discharges from the generating units through two internal outfalls into the CCS. The Permit does not authorize direct discharges to surface waters of the state. The Permit authorizes discharges from the CCS into Class G-III groundwater which is part of the surficial aquifer system. Condition IV.1 of the Permit provides that discharges to groundwater shall not cause a violation of the minimum criteria for ground water specified in Rules 62-520.400, F.A.C. and 62-520.430, F.A.C. Rule 62-520.400, F.A.C., provides that discharges to ground water shall not impair the reasonable and beneficial use of adjacent waters, either ground or surface.

5. Turkey Point Power Plant Units 3 through 5 are licensed under the Florida Power Plant Siting Act, Chapter 403, Part II, F.S. Those units operate in accordance with the conditions of certification in their license, PA 03-45. Condition of Certification X requires FPL to execute a 5th Supplemental Agreement with the South Florida Water Management District ("SFWMD") and to revise FPL's monitoring obligations, which resulted in the Turkey Point Plant Groundwater, Surface Water and Ecological Monitoring Plan, as amended, ("2009 Monitoring Plan") incorporated as Exhibit A to the Fifth Supplemental Agreement between the South Florida Water Management District and FPL entered on October 16, 2009.

6. Historical data show that, when the CCS was constructed in the 1970's, saline water had already intruded inland along the coast due to many factors such as freshwater withdrawals, drought, drainage and flood control structures, and other human activities. To date, the relative contributions of the different factors toward westward movement of the saltwater interface have not been fully identified.

7. FPL provided information on action they have already taken on several fronts to address the broader regional risks and the many causes of saltwater intrusion. In 2010, FPL installed a gated culvert approximately 3.8 miles inland of Biscayne Bay in the Card Sound Road Canal to eliminate an unrestricted inland conveyance of saltwater from the bay. Also, in 2014, FPL installed a broad, fix crested weir in the S-20 Discharge Canal to prevent the historic migration of bay saltwater up to the S-20 Canal.

8. The phrase "hypersaline water/plume" as used in this Order means water that exceeds 19,000 mg/L chlorides. The term "saltwater interface" ("SWI") as used in this Order means the intersection of class G-II and G-III groundwaters.

9. The CCS includes an approximately 18 foot deep interceptor ditch along the western edge of the CCS. As approved and constructed, the interceptor ditch system has been effective at restricting the westward movement of the saline water from the CCS in the upper portion of the aquifer but has not restricted the westward movement of saline waters into the deeper portions of the aquifer. Saline water from the CCS has moved, at depth, westward of the L-31E Canal in excess of those amounts that would have occurred without the existence of the CCS.

10. The Department issued an Administrative Order (OGC No. 14-0741) to FPL related to the CCS at Turkey Point on December 23, 2014 and made final by an Order of the Department issued on April 21, 2016. The Administrative Order requires FPL to reduce the salinity in the CCS. This Consent Order supersedes all of the requirements of that Administrative Order.

11. FPL conducted or implemented dredging, vegetation control, water stage management, and chemical additives to the CCS to maintain the thermal efficiency of the system and to control salinity and temperature.

12. Elevated salinity levels in the CCS cause, or at a minimum contribute to, the hypersaline discharges into the groundwater. Reducing the CCS surface water salinity from an elevated base salinity condition will require certain measures such as a greater

addition of relatively fresher water, removal of salt mass from the CCS, and management of CCS inflows and outflows. Ambient weather factors, such as precipitation amounts, temperatures, and regional water levels can also affect CCS salinity levels.

13. On October 7, 2015, FPL entered into a Consent Agreement with Miami-Dade County to resolve a Notice of Violation from the County dated October 2, 2015. Pursuant to paragraph 17 of the Consent Agreement, the objective is for FPL to demonstrate a statistically valid reduction in the salt mass and volumetric extent of the hypersaline water (as represented by chloride concentrations above 19,000 mg/L) in groundwater west and north of FPL's property without creating adverse environmental impacts. A further objective of the Consent Agreement is to reduce the rate of and, as an ultimate goal, arrest migration of hypersaline groundwater.

14. On April 25, 2016, the Department issued a Notice of Violation (OGC File No.: 16-0241) ("NOV") to FPL stating that the CCS is the major contributing cause to the continuing westward movement of the saline water interface, and that the discharge of hypersaline water contributes to saltwater intrusion. In the NOV, the Department found that saltwater intrusion into the area west of the CCS is impairing the reasonable and beneficial use of adjacent G-II groundwater in that area. FPL has operated the CCS under regulatory approvals, and the Department has not previously issued FPL either a Warning Letter or a Notice of Violation concerning FPL's operation of the CCS.

15. On April 25, 2016, the Department issued a Warning Letter, #WL 16-000151W13SED, to FPL concerning sampling events that indicated that ground water

originating from beneath the CCS is reaching tidal surface waters connected to Biscayne Bay in artificial deep channels immediately adjacent to the CCS. The Warning Letter requested that FPL provide facts to assist in determining whether any violations of Florida law have occurred.

16. The NOV directed FPL to enter into consultations to develop a consent order to, at a minimum, remediate the CCS contribution to the hypersaline plume, reduce the size of the hypersaline plume, and prevent future harm to waters of the State. FPL entered into consultations with the Department as required by the Orders for Corrective action in the NOV. The consultations resulted in resolutions to address the violations alleged in the NOV and issues raised in the Warning Letter, as memorialized in this Order.

17. On May 16, 2016, FPL submitted to the Department the nutrient monitoring results from certain surface water monitoring stations in deep channels adjacent to the CCS for total nitrogen, total phosphorous, TKN, and chlorophyll a. The Department reviewed the information by FPL and determined that no exceedances of surface water quality standards were detected in Biscayne Bay monitoring. This Order is intended to minimize the potential for future exceedances.

18. This Order and FPL's compliance with the requirements set forth in this Order address issues identified in the Department's Warning Letter, Administrative Order and NOV.

Respondent and the Department mutually agree and it is

ORDERED:

19. The first objective of this Order is for FPL to cease discharges from the CCS that impair the reasonable and beneficial use of the adjacent G-II ground waters to the west of the CCS in violation of Condition IV.1 of the Permit and Rule 62-520.400, F.A.C. FPL shall accomplish this first objective by undertaking freshening activities as authorized in the Turkey Point site certification, by eliminating the CCS contribution to the hypersaline plume, by maintaining the average annual salinity of the CCS at or below 34 Practical Salinity Units ("PSU"), by halting the westward migration of hypersaline water from the CCS, and by reducing the westward extent of the hypersaline plume to the L-31E within 10 years, thereby removing its influence on the saltwater interface, without creating adverse environmental impacts. The second objective of this Order is for FPL to prevent releases of groundwater from the CCS to surface waters connected to Biscayne Bay that result in exceedances of surface water quality standards in Biscayne Bay. FPL shall accomplish this second objective primarily by undertaking restoration projects in the Turtle Point Canal and Barge Basin area. The third objective of this Order is for FPL to provide mitigation for impacts related to the historic operation of the CCS, including but not limited to the hypersaline plume and its influence on the saltwater interface.

20. To achieve the first objective of this Order, FPL shall:

a. Achieve a CCS average annual salinity of at or below 34 PSU ("threshold") at the completion of the fourth year of freshening activities, which are authorized by the Turkey Point site certification modification. If FPL fails to reach an annual average salinity of at or below 34 PSU by the end of the fourth year of freshening activities, within 30 days of failing to reach the required threshold, FPL shall submit a plan to the Department detailing additional measures, and a timeframe, that FPL will implement to achieve the threshold. Subsequent to attaining the threshold in the manner set forth above, if FPL fails more than once in a 3 year period to maintain an average annual salinity of at or below 34 PSU, FPL shall submit, within 60 days of reporting the average annual salinity, a plan containing additional measures that FPL shall implement to achieve the threshold salinity level.

b. Submit a thermal efficiency plan within 180 days of the effective date of the Order that shall include a detailed description for the CCS to achieve a minimum of 70 percent thermal efficiency. This efficiency plan shall address water stage management, vegetation control, dredging, chemical additives to the CCS for facility operation, and upset recovery. FPL shall implement the efficiency plan within 90 days of being instructed to do so by the Department.

c. Implement a remediation project that shall include a recovery well system that will halt the westward migration of hypersaline water from the CCS within 3 years and reduce the westward extent of the hypersaline plume to the L-31E canal within 10 years without adverse environmental impacts.

i. Within 30 days of the effective date of this Order, provide the Department with available detailed plans for this remediation project, including supporting data, that are designed to halt the westward migration of the hypersaline plume within 3 years of commencement of the remediation project and retract the hypersaline plume to the L-31E canal within 10 years of the commencement of the remediation project. Location, volume and movement of the hypersaline plume shall be determined by Continuous Surface Electromagnetic Mapping ("CSEM") technology as detailed below.

ii. Apply for appropriate regulatory approvals within 90 days of the effective date of this Order and begin construction of this remediation project within 30 days after receipt of all necessary regulatory approvals. FPL shall advise the Department of any modifications to the submitted plans that result from regulatory reviews. FPL shall commence the operation of this remediation project upon completion of construction. FPL shall provide the Department with written notice of the date FPL commenced operation of this remediation project.

iii. For determining compliance, the westward migration of the hypersaline plume shall be deemed halted if the third CSEM survey shows no net increase in hypersaline water volume and no net westward movement in the leading edge of the hypersaline plume.

iv. To ensure overall remediation objectives are attained in a timely manner, if the second CSEM survey indicates that the net westward migration of the hypersaline plume is not being halted, then, within 180 days of the second CSEM survey, FPL shall develop and submit for approval to the Department a plan with specific actions to achieve the objectives of the remediation project. If the third CSEM survey still indicates the net westward migration of the hypersaline plume has not halted, FPL shall implement the approved additional measures within 30 days after submittal of the third CSEM report to the Department.

v. At the conclusion of the fifth year of operation of the remediation project, FPL shall evaluate and report to the Department, within 60 days, the effectiveness of the system in retracting the hypersaline plume to the L-31E canal within 10 years. If this report shows the remediation project will not retract the hypersaline plume to the L-31E canal within 10 years due to adverse environmental impacts of remedial measures or other technical issues, FPL shall provide an alternate plan for Department review and approval. FPL shall begin implementing the alternate plan within 30 days of receipt of notice that the alternate plan has been approved.

21. To achieve the second objective of this Order, FPL shall:

a. Complete Barge Basin and Turtle Point Canal restoration projects within 2 years of receiving the final regulatory approval. Within 60 days of the effective date of this Order, FPL shall provide the Department with a detailed plan and design of the restoration projects to prevent releases of groundwater from the CCS to surface waters connected to Biscayne Bay that result in exceedances of surface water quality standards in Biscayne Bay. Not more than 90 days after the effective date of this Order, FPL shall prepare and submit permit applications to relevant regulatory agencies (including the Department, the United States Army Corp of Engineers, and Miami-Dade County, as necessary) to address the restoration of the Turtle Point Canal and Barge Basin. Project success shall be based on full project completion and monitoring results of surface water sampling sites TPBBSW-4, TPBBSW-10, and TPBBSW-7T.

b. Within 90 days of the effective date of this Order, submit a detailed report outlining the potential sources of the nutrients found in the CCS, including chemical products used for plant operations. The report shall include a plan for minimizing nutrient levels in the CCS, which shall be implemented within 90 days after being instructed to do so by the Department.

c. Within 120 days of the effective date of this Order, conduct a thorough inspection of the CCS periphery including all dams, dikes, berms, and appurtenant structures using sound engineering judgment and best practices. FPL shall submit a detailed report to the Department of the inspection results, including underlying data. The inspection must be conducted by an independent qualified Florida licensed professional engineer. The term qualified means having successfully completed the Mine Safety and Health Administration Qualification for Impoundment Inspection course in addition to the Annual Retraining for Impoundment Qualification, or equivalent qualifications. The engineer shall also review available documentation and include in the report any actions necessary to ensure the integrity of the CCS. If the inspection identifies a material breach or structural defect in a peripheral levee of the CCS, FPL shall, within

60 days, submit a detailed description of the plan to address any material breaches or structural defects. FPL shall implement the plans to address any material breaches or structural defects within 60 days of the report mandated under this paragraph.

22. If FPL seeks renewal of the Combined License for either Unit 3 or 4 from the Nuclear Regulatory Commission, FPL shall provide the Department any information provided to the NRC detailing the future operating viability, including environmental and natural resource impacts, of the CCS and any potential alternative cooling technologies during the second renewal period.

23. To achieve the third objective of this Order, FPL shall undertake the following:

a. Complete an analysis, within 2 years from the effective date of this Order, with input from the Department and other agencies as selected by the Department, using the variable density three dimensional groundwater model developed under the Miami-Dade County Consent Agreement, that seeks to allocate relative contributions of other entities or factors to the movement of the SWI.

b. Enter into an agreement within 1 year with SFWMD, if SFWMD requests, to convey to SFWMD, FPL property interests in essential properties within the Biscayne Bay Coastal Wetlands Phase I project to facilitate the Comprehensive Everglades Restoration Plan in exchange for payment based on a jointly approved appraisal process or other mutually agreeable considerations. (See Attachment A).

c. Deposit $1.5 million into a Florida Department of Financial Services escrow account in accordance with an escrow agreement signed by FPL, the Department and the Florida Department of Financial Services. The escrow account shall be used to finance projects in the Turkey Point region that support mitigation of saltwater intrusion.

d. Conduct grab sampling within 90 days of the effective date of this Order, to improve trend analysis in Biscayne Bay and Card Sound surface waters, every two months, taking both top and bottom samples, for two years from the effective date of this Order at six sites as shown in Attachment B. The parameters sampled shall be: temperature, conductivity, pH, dissolved oxygen, turbidity, salinity, tritium, ammonia, nitrate + nitrite, total Kjedahl nitrogen, orthophosphate, total phosphorus, chlorophyll-*a*, total depth, and Secchi disk depth.

MONITORING REQUIREMENTS

24. Quality assurance and quality control for all monitoring requirements under this Order shall be achieved by compliance with the Quality Assurance Project Plan under the 2009 Monitoring Plan.

25. FPL shall timely apply for all regulatory approvals necessary for compliance with the monitoring requirements in this Order.

26. FPL shall continue to implement the monitoring program for the CCS, the 2009 Monitoring Plan, until such time as a monitoring plan is enacted pursuant to Section 403.087, F.S.

27. In addition to the monitoring requirements contained in the 2009 Monitoring Plan, FPL shall, within 90 days of the effective date of this Order, request or apply for regulatory approval to:

a. Obtain monitoring data from the USGS for the following wells for inclusion in the monitoring database: G-3946-S, G-3946-D, G-3900, G-3976, G-3966, and G-3699.

b. Install and monitor, consistent with the parameters and frequency set forth in the 2009 Monitoring Plan, a new 3 well cluster at G-3164. Construction shall commence within 180 days of FPL's receipt of all necessary regulatory approvals for the installation of the wells.

c. Replace and monitor, consistent with the parameters and frequency set forth in the 2009 Monitoring Plan well TPGW-8S. Construction shall commence within 180 days of FPL's receipt of all regulatory approvals necessary for compliance with this requirement.

d. Install and monitor, consistent with the parameters and frequency set forth in the 2009 Monitoring Plan a new deep well (to be designated as TPGW-20) located at the City of Homestead baseball complex, east of Kingman Road (SW 152nd Ave.) near the western parking area. Construction shall commence within 180 days of FPL's receipt of all regulatory approvals necessary for compliance with this requirement. The deep well will have a screened interval open to the deep high flow interval identified in the same manner as those described in the 2009 Monitoring Plan.

28. FPL shall expand the 2009 Monitoring Plan database to include all additional water monitoring data related to this Order required by all other governmental agencies and entities, including but not limited to the SFWMD, Nuclear Regulatory Commission, Miami-Dade County and the Florida Department of Health, as well as all monitoring data that is required in this Order.

29. In addition to the other monitoring requirements in this Order and for purposes of monitoring progress toward achievement of the hypersaline plume retraction, including determining whether the westward migration of the hypersaline plume has been halted and determining the rate of decline of saline levels in the CCS surface waters over time, the following monitoring requirements shall be met:

a. FPL shall conduct and report to the Department a baseline CSEM survey of the hypersaline plume after freshening activities are in operation but before the complete recovery well system begins operation. This will be the "Baseline Survey."

b. FPL shall conduct a CSEM survey within 30 days after the first year of recovery well operations and report the results to the Department.

c. FPL shall conduct a CSEM survey within 30 days after the second year of recovery well operations and report the results to the Department. This survey shall be the second CSEM survey.

d. FPL shall conduct a CSEM survey within 30 days after the third year of recovery well operations and report the results to the Department. This survey shall be the third CSEM survey.

e. FPL shall conduct and report to the Department subsequent CSEM surveys of the hypersaline plume 2 years after the third CSEM survey and every 2 years thereafter.

f. FPL shall monitor average weekly mass removal of salt as represented by total dissolved solids ("TDS"), by monitoring flow rate and weekly average TDS of the full extraction system, beginning at the time of commencement of the hypersaline plume remediation project operation.

g. FPL shall monitor average weekly chloride concentration of extracted water for the full extraction system, beginning at the time of commencement of the hypersaline plume remediation project operation.

h. FPL shall monitor average daily volume of hypersaline water extraction for the full extraction system, from beginning at the time of commencement of the Plume Extraction operation.

i. FPL shall maintain records of the operation of each extraction well (pump operation parameters such as: pump status, RPM, flow rate; water quality parameters such as salinity and TDS) and make such records available for review by the Department upon request, with reasonable notice.

j. FPL shall, when monitoring the salinity levels in the CCS, utilize all available monitoring resources in the CCS to obtain the average annual salinity rate. Specific monitoring points may not be excluded from the calculation unless such exclusion is allowed by the Department based upon a scientific reason. For the purposes of determining average annual salinities for the CCS, FPL shall use qualified hourly data (pursuant to the approved 2009 Monitoring Plan QAPP) from each of the CCS monitoring sites TPSWCCS-1, 2, 3, 4, 5, 6, and 7 collected beginning at 00:00 through 23:59 each day. The qualified hourly data for the day will be summed and divided by the number of qualified hourly values for the station that day. Stations with fewer than 12 qualified hourly data values in a given day shall not be used in the calculation of the CCS daily average. The daily averages for all qualified stations (up to seven per day) for a given day will be summed and divided by the number of qualified stations for that day to produce a qualified CCS daily average salinity value. The average annual salinity is calculated by summing the qualified CCS daily average salinity values from June 1st through May 31st and dividing the value by the number of days in the year.

k. FPL shall monitor TPBBSW7T consistent with the parameters and frequency in the 2009 Monitoring Plan.

30. FPL will take reasonable actions to select appropriate laboratories with sufficient capacity to avoid delay in receiving results due to backlogs. If such delay occurs, FPL will make reasonable efforts to resolve those delays.

REPORTING REQUIREMENTS

31. The Annual Monitoring Report required by the 2009 Monitoring Plan shall be expanded to include:

a. All additional water monitoring data required under this Order.

b. All additional water monitoring data related to this Order required by all other governmental agencies or entities, including but not limited to the SFWMD, Nuclear Regulatory Commission, Miami-Dade County, and the Florida Department of Health, as well as all monitoring data that is required in this Order.

c. A reporting of the average annual salinity of the CCS waters.

32. FPL shall provide a report to the Department at the conclusion of the year-long control elevation project described in paragraph 17 of the Miami-Dade Consent Agreement detailing the results of the year-long raise in control elevations in the Everglades Mitigation Bank.

33. FPL shall provide the Department a copy of all reports/summaries/reviews required under any other agreements with any other agency, such as the reports/ summaries/ reviews required by the Miami-Dade Consent Agreement.

NOTICES

34. FPL shall allow all authorized representatives of the Department access to the Facility at reasonable times for the purpose of determining compliance with the terms of this Order and the rules and statutes administered by the Department.

35. This Order supersedes all the requirements of the Administrative Order related to the CCS at Turkey Point. Upon execution of this Order, the DEP Administrative Order (OGC No. 14-0741) is hereby rescinded.

36. If any event, including administrative or judicial challenges by third parties unaffiliated with FPL, occurs which causes delay or the reasonable likelihood of delay in complying with the requirements of this Order, FPL shall have the burden of proving the delay was or will be caused by circumstances beyond the reasonable control of FPL and could not have been or cannot be overcome by FPL's due diligence. Neither economic circumstances nor the failure of a contractor, subcontractor, materialman, or other agent (collectively referred to as "contractor") to whom responsibility for performance is delegated to meet contractually imposed deadlines shall be considered circumstances beyond the control of FPL (unless the cause of the contractor's late performance was also beyond the contractor's control). Failure of regulatory agencies to issue required permits consistent with this Order shall be considered a circumstance beyond the control of FPL if FPL acted with due diligence in the permit application process. Upon occurrence of an event causing delay, or upon becoming aware of a potential for delay, FPL shall notify the Department within 2 working days and shall, within seven calendar days notify the Department in writing of (a) the anticipated length and cause of the delay, (b) the measures taken or to be taken to prevent or minimize the delay, and (c) the timetable by which FPL intends to implement these measures. If the parties can agree that the delay or anticipated delay has been or will be caused by circumstances beyond the reasonable control of FPL, the time for performance hereunder shall be extended. The agreement to extend compliance must identify the provision or provisions extended, the new compliance date or dates, and the additional measures FPL must take to avoid or

minimize the delay, if any. Failure of FPL to comply with the notice requirements of this paragraph in a timely manner constitutes a waiver of FPL's right to request an extension of time for compliance for those circumstances.

37. The Department, for and in consideration of the complete and timely performance by FPL of all the obligations agreed to in this Order, hereby conditionally waives its right to seek judicial imposition of damages, civil penalties, or injunctive relief for the violations described in the Notice of Violation and above up to the date of the filing of this Order. This waiver is conditioned upon FPL's complete compliance with all of the terms of this Order.

38. This Order is a settlement of the Department's civil and administrative authority arising under Florida law to resolve the matters addressed herein. This Order is not a settlement of any criminal liabilities which may arise under Florida law, nor is it a settlement of any violation which may be prosecuted criminally or civilly under federal law. Entry of this Order does not relieve FPL of the need to comply with applicable federal, state, or local laws, rules, or ordinances.

39. The Department hereby expressly reserves the right to initiate appropriate legal action to address any violations of statutes or rules administered by the Department that are not specifically resolved by this Order.

40. FPL is fully aware that a violation of the terms of this Order may subject FPL to judicial imposition of damages, civil penalties up to $10,000.00 per day per violation, and criminal penalties.

41. FPL acknowledges and waives its right to an administrative hearing pursuant to sections 120.569 and 120.57, F.S., on the terms of this Order. FPL also acknowledges and waives its right to appeal the terms of this Order pursuant to section 120.68, F.S.

42. Electronic signatures or other versions of the parties' signatures, such as .pdf or facsimile, shall be valid and have the same force and effect as originals. No modifications of the terms of this Order will be effective until reduced to writing, executed by both FPL and the Department, and filed with the clerk of the Department.

43. The terms and conditions set forth in this Order may be enforced in a court of competent jurisdiction pursuant to sections 120.69 and 403.121, F.S. Failure to comply with the terms of this Order constitutes a violation of section 403.161(l)(b), F.S.

44. This Order is a final order of the Department pursuant to section 120.52(7), F.S., and it is final and effective on the date filed with the Clerk of the Department unless a Petition for Administrative Hearing is filed in accordance with Chapter 120, F.S.

45. When FPL demonstrates to the Department that it has fulfilled the requirements of this Order, the Department shall notify FPL in writing that all requirements of this Order are terminated except for the requirement to maintain the average annual salinity of the CCS at or below 34 PSU until an average annual salinity of the CCS is designated in a Department permit issued subsequent to the effective date of this Order.

46. Upon the timely filing of a petition, this Order will not be effective until further order of the Department.

47. FPL shall publish the following notice in a newspaper of daily circulation in Miami-Dade County, Florida. The notice shall be published one time only within 30 days of the effective date of the Order. FPL shall provide a certified copy of the published notice to the Department within 10 days of publication.

STATE OF FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

NOTICE OF CONSENT ORDER

The Department of Environmental Protection ("Department") gives notice of agency action of entering into a Consent Order with FPL pursuant to section 120.57(4), F.S. The Consent Order addresses the westward migration of hypersaline water from the Turkey Point Facility and potential releases to deep channels on the eastern and southern side of the Facility. The Consent Order is available for public inspection during normal business hours, 8:00 a.m. to 5:00 p.m., Monday through Friday, except legal holidays, at the Department of Environmental Protection Office of General Counsel, 3900 Commonwealth Boulevard, Tallahassee, Florida 32399-3000.

Persons who are not parties to this Consent Order, but whose substantial interests are affected by it, have a right to petition for an administrative hearing under sections 120.569 and 120.57, F.S. Because the administrative hearing process is designed to formulate final agency action, the filing of a petition concerning this Consent Order means that the Department's final action may be different from the position it has taken in the Consent Order.

The petition for administrative hearing must contain all of the following information:

a) The OGC Number assigned to this Consent Order;

b) The name, address, and telephone number of each petitioner; the name, address, and telephone number of the petitioner's representative, if any, which shall be the address for service purposes during the course of the proceeding;

c) An explanation of how the petitioner's substantial interests will be affected by the Consent Order;

d) A statement of when and how the petitioner received notice of the Consent Order;

e) Either a statement of all material facts disputed by the petitioner or a statement that the petitioner does not dispute any material facts;

f) A statement of the specific facts the petitioner contends warrant reversal or modification of the Consent Order;

g) A statement of the rules or statutes the petitioner contends require reversal or modification of the Consent Order; and

h) A statement of the relief sought by the petitioner, stating precisely the action petitioner wishes the Department to take with respect to the Consent Order.

The petition must be filed (received) at the Department's Office of General Counsel, 3900 Commonwealth Boulevard, MS# 35, Tallahassee, Florida 32399-3000 within 21 days of receipt of this notice. A copy of the petition must also be mailed at the time of filing Division of Water Resource Management, Industrial Wastewater Program at 2600 Blair Stone Road, Mail Station 3545, Tallahassee, Florida 32399-2400. Failure to file a petition within the 21-day period constitutes a person's waiver of the right to request an administrative hearing and to participate as a party to this proceeding under sections 120.569 and 120.57, F.S. Before the deadline for filing a petition, a person whose substantial interests are affected by this Consent Order may choose to pursue mediation as an alternative remedy under section 120.573, F.S. Choosing mediation will not adversely affect such person's right to request an administrative hearing if mediation does not result in a settlement. Additional information about mediation is provided in section 120.573, F.S. and Rule 62- 110.106(12), Florida Administrative Code.

FOR THE RESPONDENT:

Randall R. LaBauve
Vice-President, Environmental Services
Florida Power & Light Company
700 Universe Boulevard
Juno Beach, FL 33408

DONE AND ORDERED this 20th day of June, 2016, in Tallahassee, Florda.

STATE OF FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION

John A. Coates

John A. Coates, P.E.
Director, Division of Water Resource Management

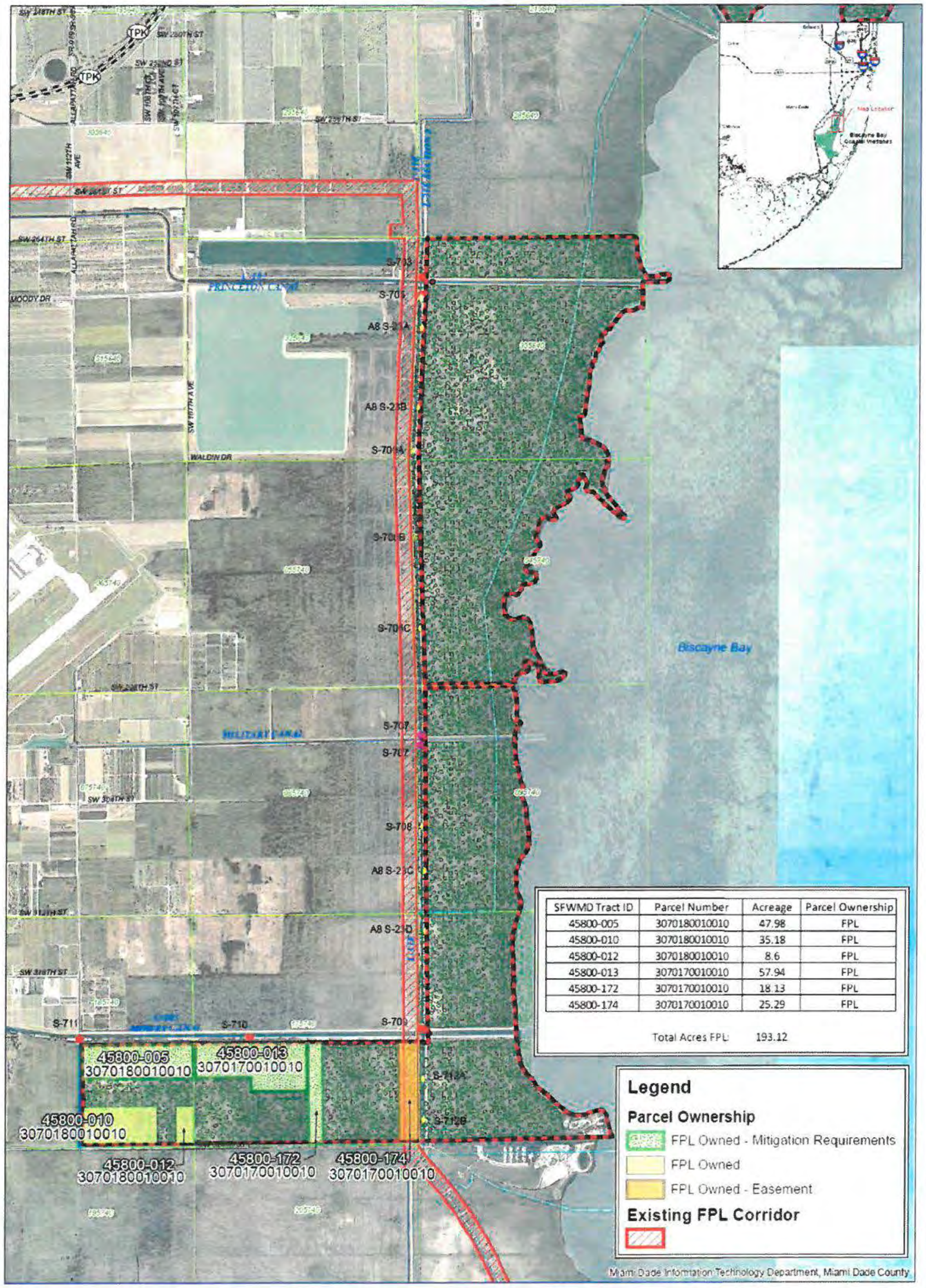
Filed, on this date, pursuant to section 120.52, F.S., with the designated Department Clerk, receipt of which is hereby acknowledged.

Clerk   Date 6/20/2016

Copies furnished to:

Lea Crandall, Agency Clerk
Mail Station 35

Attachment A



SFWMD Tract ID	Parcel Number	Acreage	Parcel Ownership
45800-005	3070180010010	47.98	FPL
45800-010	3070180010010	35.18	FPL
45800-012	3070180010010	8.6	FPL
45800-013	3070170010010	57.94	FPL
45800-172	3070170010010	18.13	FPL
45800-174	3070170010010	25.29	FPL

Total Acres FPL: 193.12

BBCW - Phase 1
L-31 East Flow-way
FPL Parcel Ownership - within Project

South Florida Water Management District
3301 Gun Club Rd. West Palm Beach, FL 33406
561-686-8800 · FL WATS 1-800-432-2045

0 0.5 1 Miles

Map Date: June 2016

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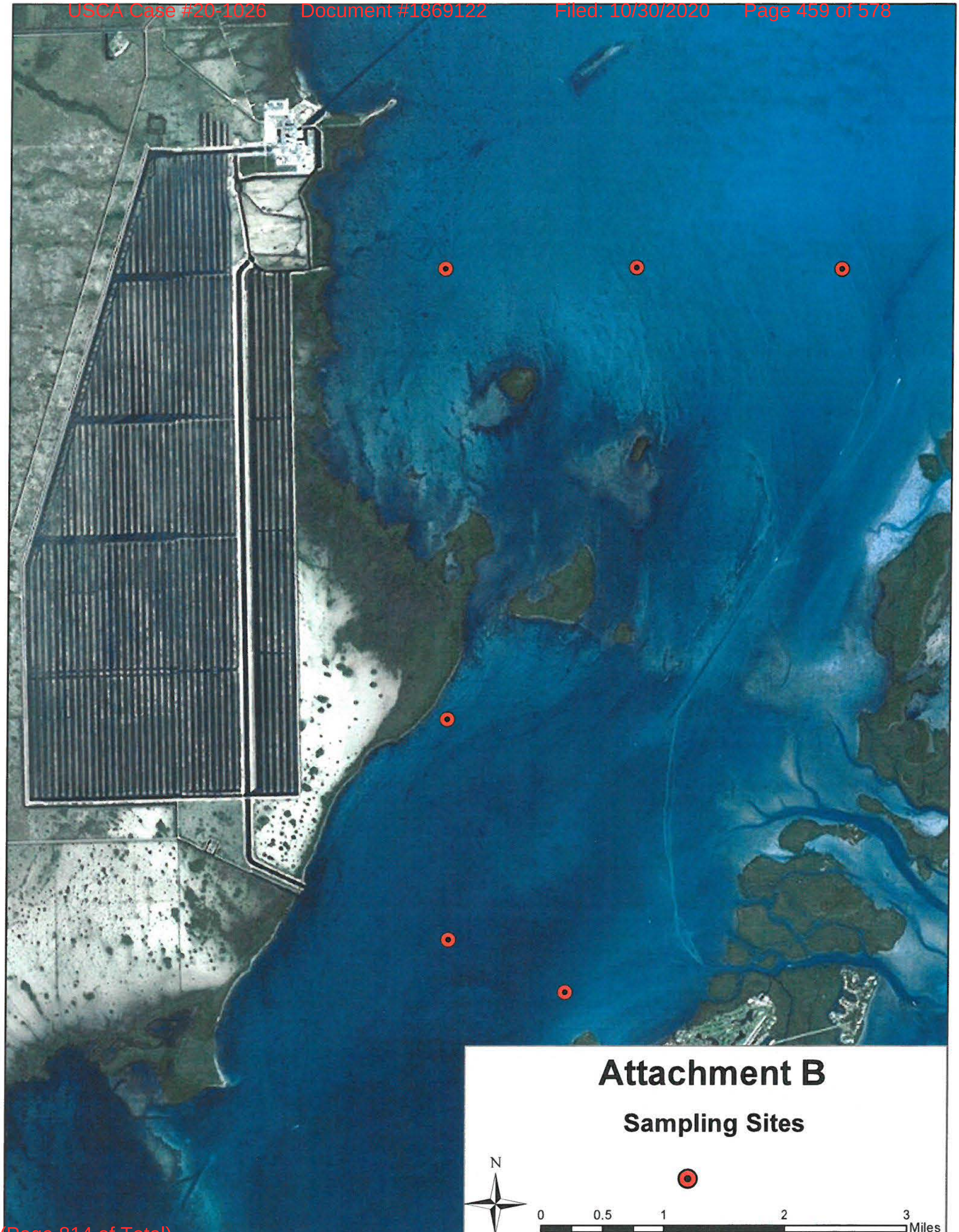
Attachment B
Sampling Sites
N
0
0.5
1
2
3
Miles

PNNL-25755

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Review Team Focused Modeling Analysis of Radial Collector Well Operation on the Hypersaline Groundwater Plume beneath the Turkey Point Site near Homestead, Florida

August 2016

M Oostrom
L Vail

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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PNNL-25755

Review Team Focused Modeling Analysis of Radial Collector Well Operation on the Hypersaline Groundwater Plume beneath the Turkey Point Site near Homestead, Florida

M Oostrom
L Vail

August 2016

Prepared for
Nuclear Regulatory Commission

Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

Researchers at Pacific Northwest National Laboratory served as members of a U.S. Nuclear Regulatory Commission review team for the Florida Power & Light Company's application for two combined construction permits and operating licenses (combined licenses or COLs) for two proposed new reactor units—Turkey Point Units 6 and 7. The review team evaluated the environmental impacts of the proposed action based on the October 29, 2014 revision of the COL application, including the Environmental Report, responses to requests for additional information, and supplemental information. As part of this effort, team members tasked with assessing the environmental effects of proposed construction and operation of Units 6 and 7 at the Turkey Point site reviewed two separate modeling studies that analyzed the interaction between surface water and groundwater that would be altered by the operation of radial collector wells (RCWs) at the site. To further confirm their understanding of the groundwater hydrodynamics and to consider whether certain actions, proposed after the two earlier modeling studies were completed, would alter the earlier conclusions documented by the review team in their draft environmental impact statement (EIS; NRC 2015), a third modeling analysis was performed. The third modeling analysis is discussed in this report.

The simulations were conducted using the water-salt-energy mode of the STOMP (Subsurface Transport Over Multiple Phases) simulator (White and Oostrom 2006). The applicable governing equations are the component mass-conservation equation for water and salt, and the energy conservation equation. The simulator allows for the consideration of density-driven flow and temperature effects caused by the seepage of warm hypersaline water from the unlined cooling-canal system (CCS) into the saline Biscayne aquifer. The model configuration was based on an earlier cross-sectional model published by Hughes et al. (2010). The two-dimensional (2D) model is 46 km long and extends 35 m vertically. The three-dimensional (3D) model that represents an extension of the 2D model is 2 km wide.

The initial conditions for both the 2D and 3D simulations are obtained using a steady-state simulation with a Biscayne Bay hydraulic head of 0.2 m and a west boundary head of 1.05 m. The long-term (10,000 year) simulations yielded a typical salt intrusion front, extending below the CCS. For the subsequent hypersaline water infiltration simulations, the same boundary conditions as proposed by Hughes et al. (2010) were used for hydraulic heads and temperature.

The main observations from the 2D simulations are as follows:

- CCS operation with warm 70 g/L hypersaline water leads to development of a large subsurface plume.
- Reducing the CCS salt concentration leads to a stable displacement of hypersaline water from the CCS subsurface.
- Increasing the hydraulic head in L-31E Canal limits westward migration of the hypersaline plume.
- Increasing the west boundary hydraulic head (indicative of increased recharge) results in a compression of the hypersaline plume at the west side of the CCS.
- Decreasing the west boundary hydraulic head (indicative of reduced recharge) has the opposite effect, leading to additional migration of the hypersaline plume in the western direction.
- During sea level rise, infiltrating saltwater from the Biscayne Bay pushes the hypersaline water toward the CCS subsurface. Over time, the interface between hypersaline water originating from the CCS and seawater becomes sharper and more vertical.

The main observations from the 3D simulations are as follows:

- Periodic extraction using the RCW system leads to fluctuating salt concentrations in the wells.
- During pumping, the concentrations initially increase because of advective transport of hypersaline water through the Upper Higher Flow Zone; the concentrations then decrease because of the influence of extracted Biscayne Bay saltwater.
- Between pumping episodes, the concentrations slightly increase due to diffusion of hypersaline water eastward; the well salt concentrations do not change significantly from year to year.
- RCW pumping increases the concentration gradients between the hypersaline plume below the CCS and Biscayne Bay saltwater in the upper parts of the aquifer and removes some of the hypersaline water from the Fort Thompson formation; the extracted volumes originate largely from the Biscayne Bay (>95 %); pumping rate reduction (up to 10% of maximum) and duration reduction (50 %) do not considerably influence well concentrations. This result indicates that the proposed RCW operation with 86,400 gal/min withdrawal rate over 60 days per year completely dominates flow and transport adjacent to the RCWs because reasonable variations in the rate and duration do not considerably influence well concentrations.
- Boundary condition modifications (i.e., L-31E Canal head and west boundary head increases) applied to the west of the CCS do not influence RCW extraction behavior.
- Seawater rise in Biscayne Bay leads to decreasing RCW saltwater concentration over time because the increasing Biscayne Bay hydraulic head displaces hypersaline water toward the CCS subsurface.
- Operation of remediation wells in the Lower Higher Flow Zone below the Interceptor Ditch does not influence extracted RCW salt concentrations.
- Salt concentrations in the remediation wells are predicted to increase to CCS levels within a year.
- Freshening of the CCS surface water results in reduced RCW salt concentrations with relatively minor (<1 g/L) fluctuations.

There is no question that some perturbations of the baseline boundary conditions result in significantly altered environmental baselines. However, while the operation of the RCWs would change the incremental impacts of the RCWs on the salinity distribution of the aquifer, the alterations would remain at levels that may only be detectable within the immediate vicinity of the RCWs. While the numerical model analysis suggest the slight westward movement of hypersalinity assumed in the conceptual model from the operation of the RCWs, it does not demonstrate any plausible upward impelling force above the RCWs that would result in hypersalinity moving into the Bay as a result of the RCWs. As the review team has acknowledged in the EIS, when the water surface elevation in the cooling canals exceeds that in the Bay, the water will follow the gradient of the impelling force into the Bay and may contribute to salinity in the Bay. Both of the above effects also apply for other tracers, including nutrients and tritium.

Although the primary focus of the review reported here is on the incremental effects of the RCWs on the Biscayne Bay, the review team also acknowledges the cumulative impacts of other changes, including those from sea level rise and possible future regulatory actions. While the scenarios considered in this analysis tended to be bounding for sea level rise and possible regulatory actions, they also provide a basis for assessing the cumulative impacts. The review team has no jurisdiction over the proposed regulatory actions considered and assumes that mitigation actions proposed by state and county agencies would improve the baseline environment. As long as the incremental effect of the RCWs remains minor, the cumulative effects would also remain minor.

The minor localized alterations in salinity distribution suggest that the operation of the RCWs is unlikely to interfere with any of the proposed mitigation actions.

Acknowledgments

The authors acknowledge the valuable comments and suggestions in scoping, performing, and documenting the analysis provided by Eric Stabenau and Kevin Kotun, South Florida Natural Resource Center, National Park Service; Dan Barnhurst, New Reactor Office, Nuclear Regulatory Commission; and Paul Thorne, Pacific Northwest National Laboratory.

Acronyms and Abbreviations

°C	degree(s) Celsius
2D	two-dimensional
3D	three-dimensional
CCS	cooling-canal system
cm	centimeter(s)
COC	Conditions of Certification
EIS	environmental impact statement
FPL	Florida Power & Light Company
ft	foot(feet)
g	gram(s)
gal	gallon(s)
IWF	industrial wastewater facility
J	joule(s)
kg	kilogram(s)
L	liter(s)
LHFZ	Lower Higher Flow Zone
m	meter(s)
RCW	radial collector well
RTF	Review Team Focused
s	second(s)
STOMP	Subsurface Transport Over Multiple Phases
UHFZ	Upper Higher Flow Zone

Contents

Figures

Tables

1.0 Introduction

Pacific Northwest National Laboratory researchers served as members of a U.S. Nuclear Regulatory Commission review team for the Florida Power & Light Company's (FPL's) 2009 application for two combined construction permits and operating licenses (combined licenses or COLs) for two proposed new reactor units—Turkey Point Units 6 and 7. The review team evaluated the environmental impacts of the proposed action based on the October 29, 2014 revision of the COL application (FPL 2014a), including the Environmental Report (ER) (FPL 2014b), responses to requests for additional information, and supplemental information. As part of this effort, team members tasked with assessing the environmental effects of proposed construction and operation of Units 6 and 7 at the Turkey Point site reviewed two separate modeling studies that analyzed how the interaction between surface water and groundwater would be altered by the operation of proposed radial collector wells (RCWs) at the site. The team performed a third modeling analysis to further confirm their understanding of the groundwater hydrodynamics and to consider whether certain actions, proposed after the two earlier modeling studies were completed, would alter the earlier conclusions documented by the review team in the draft environmental impact statement (EIS, NRC 2015). This third modeling analysis is the subject of this report. The two earlier analyses are discussed in Appendix G.2.1 and G.2.2 of the draft EIS (NRC 2015).

1.1 Purpose and Scope

2D and 3D models of the subsurface of the Turkey Point cooling-canal system (CCS, also referred to as the IWF) were developed to assess the behavior of hypersaline saltwater emanating from the CCS. The 2D simulations were conducted to investigate the effects of CCS salinity, L-31E Canal head, Interceptor Ditch head, boundary conditions, and sea level rise. The 3D model was developed to evaluate potential impacts of RCW pumping on the movement of water between the CCS, the underlying Biscayne aquifer, and the Biscayne Bay. Numeric modeling and site potentiometric surface and boundary conditions were essential elements of the assessment.

1.1.1 Numerical Modeling

Numerical models are computer codes used to analyze the response of complex physical systems. Numerical models employ mathematical representations of physical processes to transform a specific set of initial conditions, boundary conditions, and process parameters into a time series of state variables at specific locations and times. Numerical models provide reliable enforcement of irrefutable principles such as conservation of mass for complex heterogeneous domains. By consistently applying assumptions that are explicitly codified in the model and its inputs, a clearer understanding of the complex systems behavior can be achieved. Systematic perturbation of assumptions about initial conditions, boundary conditions, and model parameter provide a basis for assessing the sensitivity of assumptions and uncertainty in the overall assessment.

Numerical modeling is often a necessary element of National Environmental Policy Act assessments that involve complex physical systems such as aquifers. However, numerical models rarely are sufficient as the sole basis of an assessment. The conceptual understanding that provides the framework for the model has limitations. It is the responsibility of the analyst looking at the model results to understand the implications of these limitations on the assessment.

Multiple distinct models can be used in multiple roles to assist on the same assessment. In the Turkey Point hydrologic modeling assessment described herein three distinct models were used in three distinct ways. Numerical models with different spatial scales and resolutions, models including different process representations, and models with different goals give the analyst a stronger basis for making an assessment. It should be noted that numerical models are never perfect representations of any system and that a prudent analyst will also consider the role of monitoring and mitigation in making an impact determination in case the actual system does not fit within the assessment envelope considered. Models help the analyst determine whether monitoring is likely to detect such outliers in a timely manner. Models also help the analyst determine if the proposed mitigation will be effective.

1.1.2 Site Potentiometric Surface and Boundary Conditions

The impelling force that drives subsurface water movement is defined by the potentiometric surface—the level to which fresh water in a confined aquifer would rise were it completely pierced with wells. The potentiometric surface of the Biscayne aquifer beneath the Turkey Point site is complicated by the presence of freshwater, seawater, and hypersaline water. While these fluids are not immiscible, their density differences help to maintain an interface between them. The density differences influence the shape of the potentiometric surface. Water moves from higher potentiometric head toward lower potentiometric head proportionally to the viscosity of the fluid and intrinsic permeability of the subsurface matrix material. The potentiometric surface will shift as the water transports and the boundary conditions change.

The RCW system for Turkey Point is described in Chapter 3 of the EIS (NRC, in progress). RCWs behave more like tile drainage systems than like conventional wells. In a conventional well, all the water must move laterally into a small cross-sectional area causing significant drawdowns at the well where a RCW moves the volume vertically through a much larger cross-sectional area. For instance, the nominal increase in cross-sectional area of a conventional 6 in. well screened over 100 ft relative to the surface area of a RCW with 100 ft radial arms is a 400 factor increase. This results in smaller perturbations in the potentiometric surface and emphasizes vertical water motion over lateral water motion. RCWs are placed at shallow depths beneath surface waterbodies that effectively provide an unconstrained source of water or a boundary condition unaffected by withdrawal from the RCWs. Differences on stratigraphy and hydraulic conductivity also influence the potentiometric surface around RCWs.

A variety of boundary conditions exist at the Turkey Point site, including potentiometric boundary conditions and salinity boundary conditions. Biscayne Bay represents both a specified potentiometric boundary condition and a specified salinity boundary condition to the upper surface of the conceptual model. The Bay potentiometric boundary condition varies in response to tides, storm surge, and sea level rise. The industrial wastewater facility (IWF) cooling canals, Interceptor Ditch, and L-31 Canal also represent potentiometric and salinity boundary conditions on the upper surface of the conceptual model. These boundary conditions may also vary over time and space.

The western vertical boundary is also represented by a specified potentiometric and salinity boundary condition. Wet periods cause this boundary condition to rise and dry periods cause this boundary to fall.

Two types of wells, the RCWs and remediation wells, also represent specified flux sink boundary conditions. The RCWs are the focus of this assessment. As discussed in Section 2.3, the remediation wells are proposed to abate the westward migration of the hypersaline plume. The exact design of this proposed remediation system is not known at this time.

All of the boundary conditions experience differing degrees of normal variability. For instance, a significant rainfall event will increase the potentiometric head in the western boundary, decrease the salinity in the cooling canals, increase the head in the cooling canals, increase head in the L-31 Canal, increase recharge, and decrease salinity in Biscayne Bay. Also, boundary conditions are linked to varying degrees. For instance, an increase in the Bay water surface elevation can influence the elevation of water in the cooling canals. Including these linkages and time-varying boundary conditions can make it more difficult for the analyst to understand the results because of too many confounding factors. One of the benefits of numerical models is that they allow selective and limited interactions of boundary conditions to reduce the confounding issues in interpreting the model results.

The spatial distribution of the salinity at the initiation of operation is the dominant initial condition. The location of the hypersaline plume and the freshwater-seawater interface are initial conditions. As discussed in Section 2.3, a variety of regulatory actions related to the IWF may alter the initial conditions before the proposed Units 6 and 7 would ever require operation of the RCWs. The initial conditions developed through a sequence of processes that occurred in the past. Prior to operation of the RCWs and the IWF a freshwater-saltwater interface formed based on patterns of freshwater flow from the aquifer to the ocean. As inland water demands and recharge patterns changed the saltwater interface moved farther inland. During this period, the IWF was constructed and the denser hypersaline water that occurred at times moved downward under the unlined cooling canals and displaced the less dense water below, thereby resulting in a hypersaline plume that extends all the way down to the base of the aquifer.

The hypersaline groundwater plume formed beneath the cooling-canal system that was used for Turkey Point Units 1, 2, 3, 4, and 5. The proposed Units 6 and 7 would rely primarily on reclaimed water from a regional wastewater treatment plant and discharge blowdown into a very deep formation called the Boulder Zone. Therefore, the review team determined that under normal operation the cooling system impact of Units 6 and 7 on the shallow subsurface aquifer and cooling canals would be de minimis. However, the proposed design for Units 6 and 7 also includes an RCW system as a backup in case of a loss of access to reclaimed water. The RCWs are designed to encourage downward movement of water from Biscayne Bay into a set of shallow laterals. However, the review team determined that even a very shallow depression in the potentiometric head in the aquifer around the RCW will result in some lateral movement in the groundwater.

1.2 Report Contents and Organization

The ensuing sections of this report contain brief descriptions of the site being modeled, the simulator used to model site behaviors, the 2D and 3D model configurations, the associated parameter values, and how the initial and bounding conditions were derived for the simulations. Section 7.0 provides a tabulated overview of the simulations by case number and title as a lead into the presentation of the 2D and 3D simulation results in Sections 8.9 and 9.0. A discussion of the results is provided in Section 10.0. Conclusions of the overall assessment are provided in Section 11.0.

2.0 Site Description

The 2D model configuration was based on an earlier cross-sectional model published by Hughes et al. (2010). The 2D model (Figure 2.1) has a length of 46 km and a vertical extent of 35 m. The 3D model represents an extension of the 2D model and has a width of 2 km. Both models extend approximately 15.5 km farther offshore than shown in Figure 2.1, allowing for the evaluation of Biscayne Bay effects. The models represents part of the Turkey Point power plant large CCS overlying a permeable limestone aquifer. At its maximum extent (south of the 2D model cross section), the CCS has 40 canals, 32 of which transport warm water toward the south (i.e., discharge canals), and 8 of which return water to the plant (i.e., return canals). In the model cross section used by Hughes et al. (2010) and for this modeling effort, 22 discharge and 8 return canals are intersected by the cross section used. The 60 m wide canals are separated by 27 m wide berms. The cooling water salinity is considerably higher than the natural salt concentrations in groundwater in the aquifer, which likely leads to unstable density-dependent convection. The cooling water temperatures are also higher than those of the aquifer water, which potentially reduces the density effects. A more detailed description of the CCS can be found in Section 2.3 of the Turkey Point Units 6 and 7 EIS (NRC 2016). Water exchange between the CCS and groundwater occurs because the canals are unlined. An Interceptor Ditch (Figure 2.1), located west of the CCS, is used to create an artificial groundwater gradient that inhibits shallow flow of the hypersaline water from the CCS to the west. Another prominent feature is the L-31E Canal, located just west of the Interceptor Ditch. The subsurface of the model area consists of an unconfined surficial aquifer characterized by the presence of two relatively thin very high-permeability zones (Cunningham et al. 2006) with hydraulic conductivities larger than 1,000 m/day.

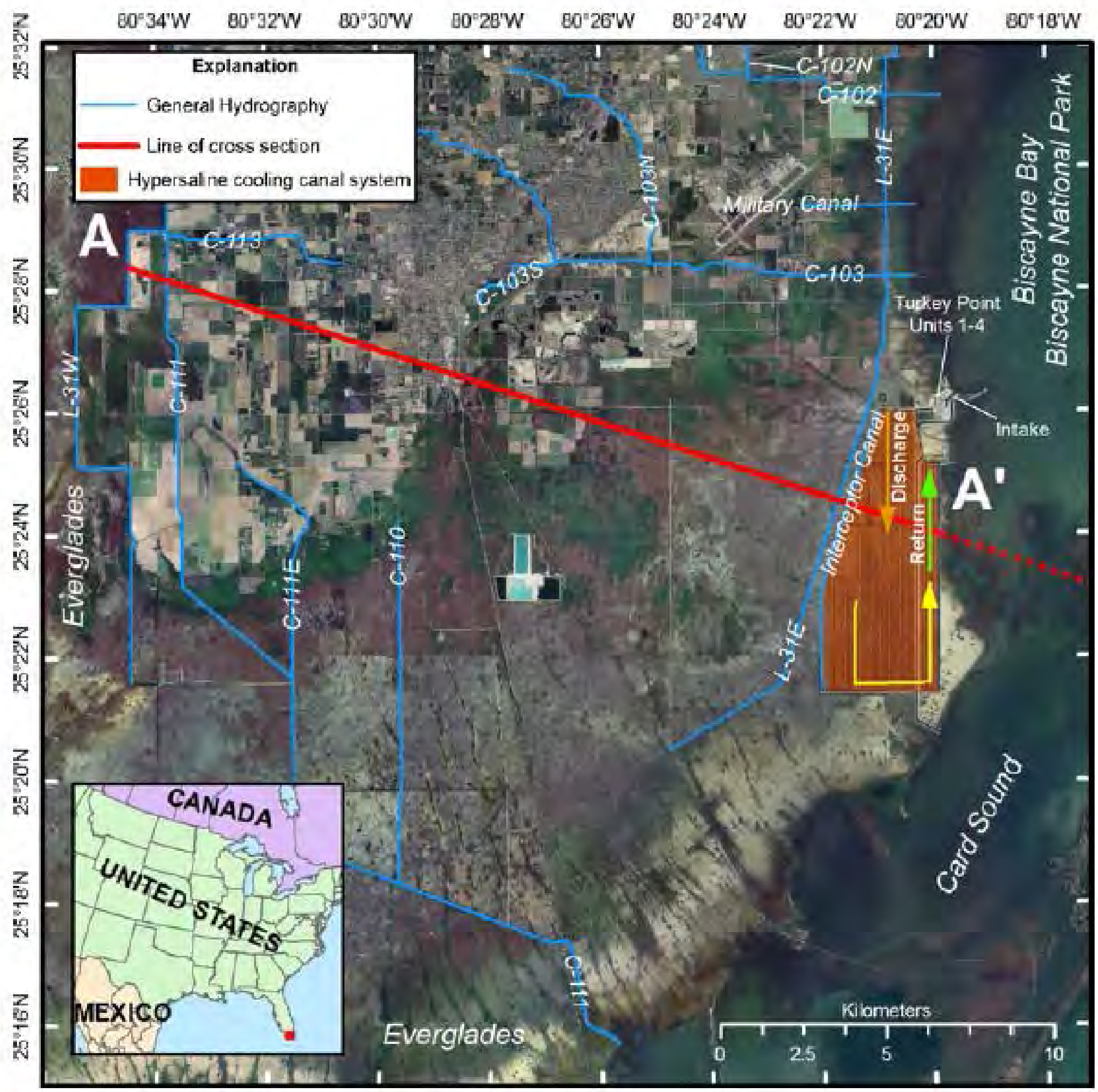

Figure 2.1. Cross-sectional model of the Turkey Point CCS (after Hughes et al. 2010). Note that the model extends approximately 15,500 m farther offshore than shown in the figure. The general hypersaline CCS flow direction is indicated with arrows.

3.0 Numerical Simulator

The simulations were conducted using the water-salt-energy mode of the STOMP (Subsurface Transport Over Multiple Phases) simulator (White and Oostrom 2006). The applicable governing equations are the component mass-conservation equation for water and salt, and the energy conservation equation. The simulator allows for the consideration of density-driven flow and temperature effects caused by the seepage of warm hypersaline water from the unlined canals of the CCS into the saline Biscayne aquifer. The governing partial differential equations are discretized with the integrated-volume finite difference method by integrating over a control volume. Using Euler backward time differencing, which yields a fully implicit scheme, a series of nonlinear algebraic expressions is derived. The algebraic forms of the nonlinear governing equations are solved with a multi-variable, residual-based Newton-Raphson iterative technique, in which the Jacobian coefficient matrix is composed of the partial derivatives of the governing equations with respect to the primary variables.

4.0 Model Configuration and Discretization

The layered configuration of the Biscayne aquifer and assignment of hydraulic properties to the layers were based on work performed by FPL and documented in the Final Safety Analysis Report and reports related to the power uprate for FPL Units 3 and 4. Figure 4.1 shows the geologic layering of the current model, including the thin Upper Higher Flow Zone (UHFZ) and the Lower Higher Flow Zone (LHFZ) of the Miami Limestone. Other units are the remainder of the Miami Limestone, the Key Largo, and the Fort Thompson formations. The model includes 22 discharge canals and 8 return canals, consistent with the cross section shown in Figure 4.1. The easternmost discharge canal is the Grand Canal, which is approximately 4 m deeper than the adjacent canals. The hydraulic conductivities assigned to the model layers are shown in Table 5.2 (see Section 5.0). For the 3D model, the same stratigraphy was used throughout the computational domain. In the current model configuration, the two "higher flow zones" were defined to be 1 m thick based on borehole data, rather than the 3 m thickness used by Hughes et al. (2010).

The 3D model configuration is shown in Figure 4.2. The model has a total width of 2 km, although the numerical model only comprises the right half of the total domain using the center line as a line of symmetry. The 3D model incorporates three RCWs, located 1,500, 1,700, and 1,900 m into the Biscayne Bay. Each RCW has a horizontal length of 150 m in the right half of the computational domain and all RCW laterals are installed in the UHFZ. The RCWs are assumed to operate continuously or for 60 days per year at a maximum pumping rate of 86,400 gal/min. The model also has the option to use up to 10 vertical remediation wells with open intervals located below the Interceptor Ditch in the LHFZ). FPL plans to install and operate these wells along the western side of the CCS to remove hypersaline water and limit its migration to the west. The extracted water will be pumped at a maximum combined rate of 12,000,000 gal/day. The 2D domain was discretized into 876 × 45 grid cells for a total of 39,420 nodes. Considerable refinement of the model grid was applied below the CCS. For the 1 km width of the 3D model, 72 grid cells were used, resulting in a total of 2,838,420 nodes.

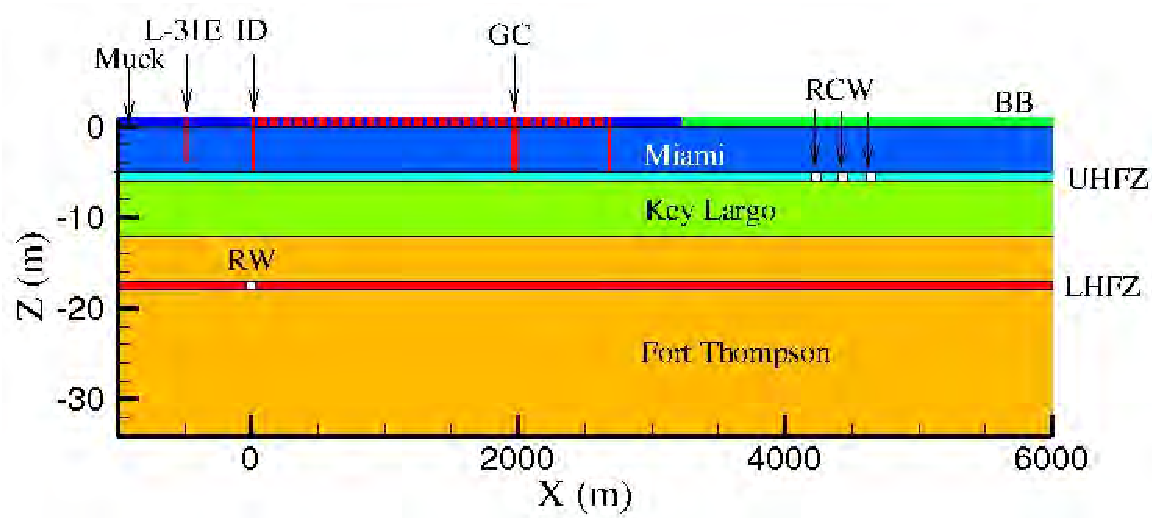

Figure 4.1. Geologic Layering and Location of the CCS (including the Grand Canal; GC) L-31E Canal, Interceptor Ditch (ID), Biscayne Bay (BB), Radial Collector Wells (RCW), and Remediation Wells (RW)

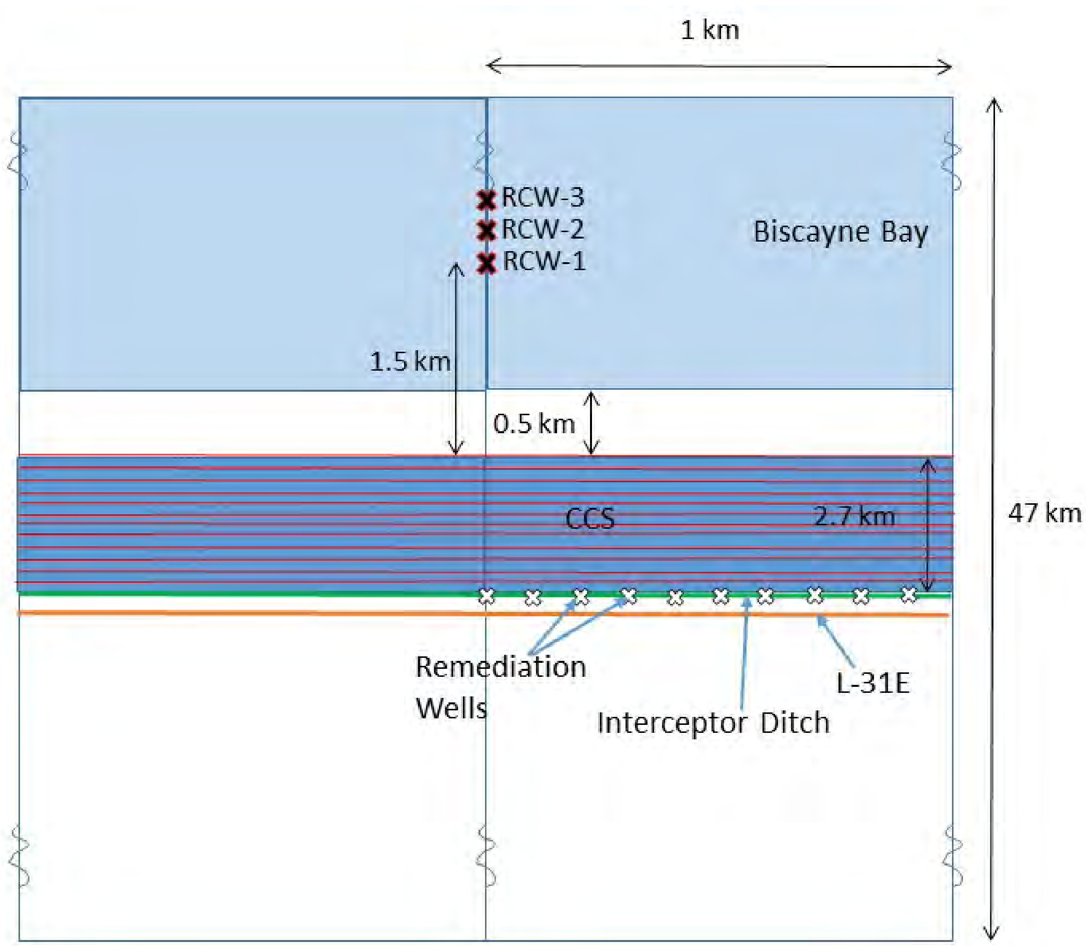

Figure 4.2. Top View of the Symmetrical 3D Model

5.0 Parameter Values

The fluid and aquifer properties are summarized in Table 5.1. The density-concentration relationships were obtained from Millero and Huang (2009). The hydraulic conductivities of the layers are listed in Table 5.2.

Table 5.1. Model Parameter Values

Model Parameter	Value
Reference Temperature (°C)	20
Land Surface Temperature (°C)	24.4
Seawater Temperature (°C)	26.2
Cooling-Canal System Temperature (°C)	35.6
Longitudinal Dispersivity (m)	1
Transverse Dispersivity (m)	0.1
Molecular Diffusion Coefficient Salt (m^2/s)	1.477e-09
Porosity	0.2
Particle Density (kg/m^3)	2650
Specific Heat Fluid (J/(kg°C))	4.183
Specific Heat Sediment (J/(kg°C))	835.0
Thermal Conductivity Fluid (J/(m°Cs))	0.61
Thermal Conductivity Sediment (J/(m°Cs))	3.59
Seawater Concentration (g/L)	35.0
Cooling-Canal Salt Concentration (g/L)	70.0

Table 5.2. Hydraulic Conductivity of the Model Layers (FPL 2015)

Layer Name	Horizontal Hydraulic Conductivity (cm/s)	Vertical Hydraulic Conductivity (cm/s)
Muck	0.0044	0.00044
Miami Limestone	0.088	0.00590
Upper High Flow Zone	30.0	3.700
Key Largo	5.90	0.740
Fort Thompson	0.33	0.033
Lower High Flow Zone	1.70	0.170

6.0 Initial and Boundary Conditions

The initial conditions for both the 2D and 3D simulations were obtained using a steady-state simulation with a Biscayne Bay hydraulic head of 0.2 m and a west boundary head of 1.05 m. The long-term (10,000 year) simulations yielded a typical salt intrusion front, extending below the CCS. For the subsequent hypersaline water infiltration simulations, the same boundary conditions as those proposed by Hughes et al. (2010) were used (Table 6.1) for hydraulic heads and temperature. Between the L-31E Canal and the west boundary, a no-flux boundary was established for the model surface without the consideration of spatial and temporal variations in local recharge. Instead, regional groundwater flow was assumed to enter solely from the west boundary.

Table 6.1. Overview of Imposed Boundary Condition for Hydraulic Head, Temperature, and Salt Concentration.

Feature	Hydraulic Head (m)	Temperature (°C)	Salt Concentration (g/L)
West Boundary	1.05	24.4	0
L-31E Canal	0.48	24.4	0
Interceptor Ditch	0.43	24.4	0
Discharge Canals	0.39	35.6	70
Return Canals	0.09	34.2	70
Biscayne Bay	0.20	28.2	35

7.0 Overview of the 2D and 3D Simulations

Overviews of the conducted 2D and 3D simulations are provided in Table 7.1 and Table 7.2, respectively. The 2D and 3D Base Case simulations involve a 25-year infiltration event of 70 g/L hypersaline water. Each sensitivity simulation has a duration of 40 years.

Table 7.1. Overview of 2D Sensitivity Simulations

Name	Variation with Base Case	Results Figures	Comments
2D-1	0 g/L salt concentration in CCS	8,4, 8.5, 8.6	Representative of freshwater.
2D-2	34 g/L salt concentration in CCS	8.7, 8.8, 8.9	Seawater concentration. Consistent with proposed freshening targets mentioned in Section 2.3 of the EIS.
2D-3	90 g/L salt concentration in CCS	8.10, 8.11, 8.12	Extreme hypersaline. No freshening.
2D-4	Head in CCS doubled	8.13, 8.14, 8.15	Potentiometric head increase in CCS. Increase consistent with freshening.
2D-5	Seawater rise in Biscayne Bay of 0.5 m over 40 years	8.16, 8.17, 8.18	Plausible sea level rise.
2D-6	Seawater rise in Biscayne Bay of 1.5 m over 40 years	8.19, 8.20, 8.21	Plausible sea level rise.
2D-7	Head in L-31E Canal increased by 0.5 m	8.22, 8.23, 8.24	Shallow hydraulic control of westward migration proposed by Miami-Dade County Department of Environmental Resources Management.
2D-8	Head at west boundary increased by 1.0 m	8.25, 8.6, 8.27	Rehydration of inland including Model Lands.
2D-9	Head at west boundary decreased by 1.0 m	8.28, 8.29, 8.30	Drought of inland and Model Lands.

Table 7.2. Overview of 3D Simulations

Name	Description	Results Figures
3D Base Case	86,400 gal/min divided evenly over three wells (RCW-1, RCW-2, and RCW-3). Wells operate 60 days per calendar year. Total system operation time 20 years. CCS operating with 70 g/L salt concentration.	9.1, 9.3
3D-1	As Base Case but no pumping	9.2, 9.3
Pumping Scenarios		
3D-2	As Base Case but with half the extraction rate (43,200 gal/min)	9.4
3D-3	As Base Case but with one-tenth of the extraction rate (8,640 gal/min)	9.5
3D-4	As Base Case but with 30 days per year of operation	9.6
3D-5	As Base Case but only two operational cycles during the first two years and no pumping afterwards	9.7
3D-6	As Base Case but with continuous pumping	9.8
Variations in Boundary Condition Scenarios		
3D-7	As Base Case but with 0.5 m elevated head in L-31E Canal	9.9, 9.10, 9.11
3D-8	As 3D-7 but without pumping	9.10b, 9.11
3D-9	As Base Case but with 1 m increased head at west boundary	9.12, 9.13a, 9.14
3D-10	As 3D-9 but without pumping	9.13b, 9.14
3D-11	As Base Case but with 1 m decreased head at west boundary	9.15, 9.16a, 9.17
3D-12	As 3D-11 but without pumping	9.16b, 9.17
3D-13	As Base Case but with 1.5 m sea level rise over 40 years	9.18, 9.19a, 9.20
3D-14	As 3D-13 but without pumping	9.19b, 9.20
3D-15	As Base Case but with 0.5 m sea level rise over 40 years	9.21, 9.22a, 9.23
3D-16	As 3D-15 but without pumping	9.22b, 9.23
Consideration on Remedial Pumping West of CCS		
3D-17	As Base Case but with 4 remediation wells continuously operating at 12,000,000 gal/day	9.24, 9.25
Scenarios after Aquifer Refreshing		
3D-18	Pumping after refreshing with 34 g/L salt water from CCS for 25 years. 86,400 gal/min divided evenly over three wells (RCW-1, RCW-2, and RCW-3). Total system time 20 years. CCS operating with 34 g/L salt concentration.	9.26
3D-19	As 3D-18 but without pumping.	9.27
3D-20	As 3D-18 but with 1.5 m sea level rise over 40 years	9.28
3D-21	As 3D-18 but with 1 m decreased head at west boundary, 1m increased head in CCS, and 1.5 m sea level rise over 40 years	9.29
3D-22	Initial conditions with pristine aquifer. CCS operating for 20 years with 34 g/L salt concentration. Pumping as in 3D-18.	9.30

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Environmental Impact Statement for Combined Licenses (COLs) for Turkey Point Nuclear Plant Units 6 and 7

Final Report

Chapters 1 to 6

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EXECUTIVE SUMMARY

This environmental impact statement (EIS) presents the results of a U.S. Nuclear Regulatory Commission (NRC) environmental review of an application for a combined construction permit and operating license (combined license or COL) for two new nuclear reactor units at a proposed Turkey Point site in Miami-Dade County, Florida. The U.S. Army Corps of Engineers (USACE) participated in the preparation of the EIS as a cooperating agency and as a member of the review team, which consisted of the NRC staff, its contractor staff, and the USACE staff. The National Park Service (NPS) participated in the environmental review as a cooperating agency by providing special expertise for the areas in and around the adjacent national parks (Biscayne and Everglades National Parks). The NPS does not have a request to take any specific regulatory actions related to the proposed COLs before it. Due to this unique set of circumstances, all impact determinations made in this EIS should not be attributed to NPS, but only to the NRC and USACE (also referred to as the review team). The NPS's participation in connection with this EIS does not imply NPS concurrence.

Background

On June 30, 2009, the Florida Power & Light Company (FPL) submitted an application to the NRC for a combined construction permit and operating license (combined license or COL) for Turkey Point Units 6 and 7.

Upon acceptance of FPL's application, the NRC review team began the environmental review process by publishing a Notice of Intent to prepare an EIS and conduct scoping in the *Federal Register* on June 15, 2010. As part of this environmental review, the review team did the following:

- conducted public scoping meetings on July 15, 2010 in Homestead, Florida
- conducted a site visit of the proposed Units 6 and 7 plant area on the Turkey Point site in June 2010
- conducted visits to alternative sites in July 2010
- reviewed FPL's Environmental Report (ER)
- consulted with Tribal Nations and other agencies such as the U.S. Fish and Wildlife Service (FWS), Advisory Council on Historic Preservation, Florida Fish and Wildlife Conservation Commission, National Marine Fisheries Service, Miami-Dade Office of Historic and Archaeological Resources, and Florida Division of Historical Resources
- conducted the review following guidance set forth in NUREG-1555:
  - "Standard Review Plans for Environmental Reviews for Nuclear Power Plants
  - Supplement 1: Operating License Renewal"
- considered public comments received during the 60-day scoping process from June 15, 2010 to August 16, 2010

- conducted public meetings on the draft EIS on April 22, 2015, in Miami, Florida, and on April 23, 2015, in Homestead, Florida
- considered public comments received during the comment periods for the draft EIS, which extended from March 5 to May 22 and from May 28 to July 17, 2016.

Proposed Action

FPL initiated the proposed Federal action by submitting an application for Turkey Point Units 6 and 7 to the NRC. The NRC's Federal action is issuance of COLs for two Westinghouse AP1000 reactors at the Turkey Point site near Homestead, Florida.

The USACE is a cooperating agency in preparation of this EIS. The USACE's Federal action is its decision of whether to issue, deny, or issue with modifications a Department of Army (DA) permit pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899 to authorize certain construction activities potentially affecting waters of the United States.(1)

Purpose and Need for Action

The purpose of the proposed NRC action, issuance of the COL, is to provide for additional baseload electric generating capacity for use in the FPL service territory.

The USACE determines both a basic and an overall project purpose pursuant to the Clean Water Act Section 404(b)(1) Guidelines, 33 CFR § 230.10. The basic purpose is to meet the public's need for electric energy. The overall purpose is to meet the public's need for reliable increased electrical baseload generating capacity in FPL's service territory.

Affected Environment

The Turkey Point site is located in southeast Miami-Dade County, Florida, near Homestead (Figure ES-1). Turkey Point Units 6 and 7 would be located on the same site as the existing Turkey Point site, which has five other power plants, including two nuclear power reactors. Turkey Point would be located 25 mi south of Miami and 4.5 and 8 mi east of Homestead and Florida City, respectively. The primary source of cooling water would be reclaimed wastewater and the alternative source would be saltwater supplied from radial collector wells beneath Biscayne Bay. The ultimate heat sink for Turkey Point Units 6 and 7 would be the atmosphere, using three mechanical draft cooling towers per reactor.

(1) Waters of the United States" is used to include both "waters of the United States" as defined by 33 CFR Part 328 (TN1683) defining the extent of USACE geographic jurisdiction pursuant to Section 404 of the Clean Water Act and "navigable waters of the United States" as defined by 33 CFR Part 329 (TN4770) defining the extent of USACE geographic jurisdiction pursuant to Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. § 403) (TN4768).

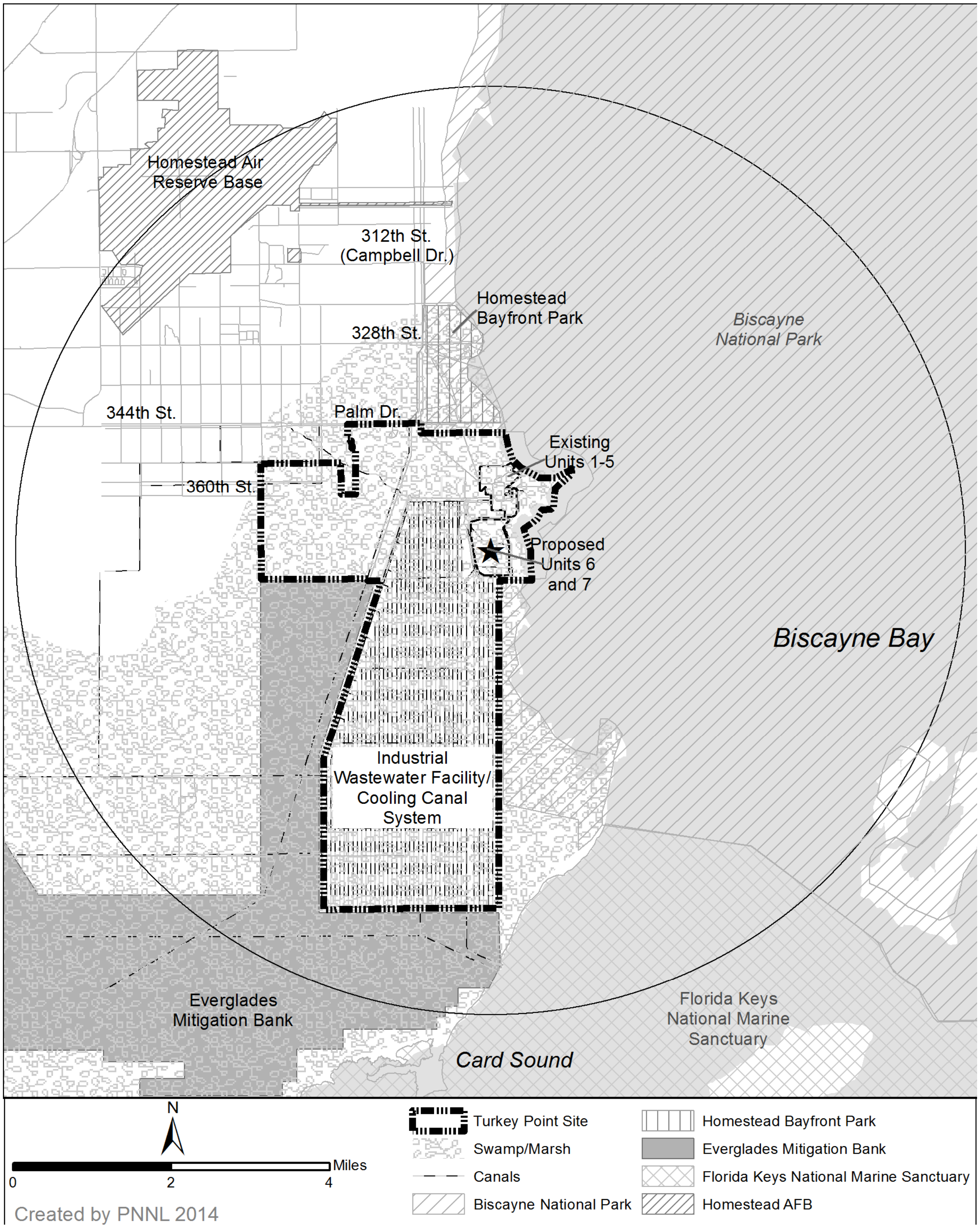


Figure ES-1. The Turkey Point Site and Affected Environment

Evaluation of Environmental Impacts

This EIS evaluates the potential environmental impacts of the construction and operation of the two new nuclear plants proposed for the Turkey Point site related to the following resource areas:

- land use
- air quality
- aquatic ecology
- terrestrial ecology
- surface and groundwater
- waste (radiological and nonradiological)
- human health (radiological and nonradiological)
- socioeconomics
- environmental justice
- cultural resources
- fuel cycle, decommissioning, and transportation

SMALL: Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

MODERATE: Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

LARGE: Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The impacts are designated as SMALL, MODERATE, or LARGE. The incremental impacts related to the construction and operations activities requiring NRC authorization are described and characterized, as are the cumulative impacts resulting from the proposed action when the effects are added to, or interact with, other past, present, and reasonably foreseeable future effects on the same resources. A summary of the construction and operation impacts are outlined in Table ES-1. Table ES-2 summarizes the review team's assessment of cumulative impacts. The review team's detailed analysis which supports the impact assessment of the proposed new units can be found in Chapters 4, 5, and 7, respectively.

Table ES-1. Environmental Impact Levels of the Proposed Turkey Point Units 6 and 7

Resource Category	Preconstruction and Construction	Operation
Land Use	MODERATE (NRC authorized construction impact level is SMALL)	MODERATE
Water-Related		
Water Use – Surface Water	SMALL	SMALL
Water Use – Groundwater Use	SMALL	SMALL
Water Quality – Surface Water	SMALL	SMALL
Water Quality – Groundwater	SMALL	SMALL
Ecology		
Terrestrial Ecosystems	MODERATE (NRC authorized construction impact level is SMALL)	MODERATE
Aquatic Ecosystems	SMALL to MODERATE	SMALL
Socioeconomic		
Physical Impacts	SMALL (adverse) to MODERATE (beneficial)	SMALL (adverse) to MODERATE (beneficial)
Demography	SMALL	SMALL
Economic Impacts on the Community	SMALL	SMALL and beneficial
Infrastructure and Community Services	SMALL to MODERATE	SMALL to MODERATE
Environmental Justice	NONE[a]	NONE[a]
Historic and Cultural Resources	MODERATE (NRC authorized construction impact level is SMALL)	SMALL
Air Quality	SMALL	SMALL
Nonradiological Health	SMALL	SMALL
Nonradiological Waste	SMALL	SMALL
Radiological Health	SMALL	SMALL
Postulated Accidents	n/a	SMALL
Fuel Cycle, Transportation, and Decommissioning	n/a	SMALL

(a) A determination of “NONE” for Environmental Justice analyses does not mean there are no adverse impacts to minority or low-income populations from the proposed project. Instead, an indication of “NONE” means that while there are adverse impacts, those impacts do not affect minority or low-income populations in any disproportionate manner, relative to the general population.

Table ES-2. Cumulative Impacts on Environmental Resources, Including the Impacts of Proposed Turkey Point Units 6 and 7

Resource Category	Impact Level
Land Use	MODERATE
Water-Related	
Water Use – Surface Water	SMALL
Water Use – Groundwater Use	SMALL
Water Quality – Surface Water	MODERATE
Water Quality – Groundwater	SMALL
Ecology	
Terrestrial Ecosystems	MODERATE to LARGE
Aquatic Ecosystems	MODERATE
Socioeconomic	
Physical Impacts	SMALL adverse to MODERATE beneficial
Demography	SMALL
Economic Impacts on the Community	SMALL and beneficial
Infrastructure and Community Services	SMALL to MODERATE
Environmental Justice	NONE[a]
Historic and Cultural Resources	MODERATE
Air Quality	SMALL to MODERATE for criteria pollutants and MODERATE for GHGs
Nonradiological Health	SMALL
Nonradiological Waste	SMALL
Radiological Health	SMALL
Postulated Accidents	SMALL
Fuel Cycle, Transportation, and Decommissioning	SMALL

(a) A determination of "NONE" for Environmental Justice analyses does not mean there are no adverse impacts to minority or low-income populations from the proposed project. Instead, an indication of "NONE" means that while there are adverse impacts, those impacts do not affect minority or low-income populations in any disproportionate manner, relative to the general population.

Alternatives

The review team considered the environmental impacts associated with alternatives to issuing a COL for the two new nuclear units proposed by FPL for the Turkey Point site. These alternatives included a no-action alternative (i.e., not issuing the COL) and alternative energy sources, siting locations, and system designs.

The no-action alternative would result in the COL not being granted or the USACE not issuing its permit. Upon such a denial, construction and operation of new units at the Turkey Point site would not occur and the predicted environmental impacts would not take place. If no other facility would be built or strategy implemented to take its place, the benefits of the additional electrical capacity and electricity generation to be provided would also not occur and the need for baseload power would not be met.

Based on the NRC staff's review of energy alternatives, the NRC staff concluded that, from an environmental perspective, none of the viable alternatives is environmentally preferable to building a new baseload nuclear power generation plant at the Turkey Point site. The NRC staff eliminated several energy sources (e.g., wind, solar, geothermal, and biomass) from full consideration because they are not currently capable of meeting the need of this project. None of the viable baseload alternatives (natural gas, coal, or a combination of alternatives) was environmentally preferable to the proposed Turkey Point units.

After comparing the cumulative effects of a new nuclear power plant at the proposed site against those at the alternative sites, the NRC staff concluded that none of the alternative sites would be environmentally preferable to the proposed site for building and operating a new nuclear power plant (Table ES-3). The four alternatives sites selected were as follows (Figure ES-2):

- Glades
- Martin
- Okeechobee 2
- St. Lucie.

Table ES-3. Comparison of Cumulative Impacts at the Turkey Point and Alternative Sites

Resource Category	Turkey Point Site[(a)]	Glades[(b)]	Martin[(b)]	Okeechobee 2[(b)]	St. Lucie[(b)]
Land Use	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
Water-Related					
Surface-water use	SMALL	MODERATE	MODERATE	MODERATE	SMALL
Groundwater use	SMALL	SMALL	SMALL	SMALL	SMALL
Surface-water quality	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
Groundwater quality	SMALL	SMALL	SMALL	SMALL	SMALL
Ecology					
Terrestrial and wetland ecosystems	MODERATE to LARGE	MODERATE	MODERATE	MODERATE	MODERATE
Aquatic ecosystems	MODERATE	MODERATE	MODERATE	MODERATE	SMALL to MODERATE
Socioeconomics					
Physical impacts	SMALL adverse except for MODERATE beneficial impacts on road quality	MODERATE adverse to SMALL beneficial impacts on road quality	MODERATE adverse to MODERATE beneficial impacts on road quality	MODERATE adverse to SMALL beneficial impacts on road quality	LARGE adverse to MODERATE beneficial impacts on road quality
Demography	SMALL	SMALL	SMALL	SMALL	SMALL, except for LARGE residential displacement impacts
Economic impacts on the community	SMALL and beneficial	SMALL and beneficial, except for LARGE and beneficial property tax revenues for Glades County and School District	SMALL and beneficial, except for MODERATE and beneficial property tax revenues for Martin County and School District	SMALL and beneficial, except for LARGE and beneficial property tax revenues for Okeechobee County and School District	SMALL and beneficial

Table ES-3. (contd)

Resource Category	Turkey Point Site[(a)]	Glades[(b)]	Martin[(b)]	Okeechobee 2[(b)]	St. Lucie[(b)]
Infrastructure and community services	SMALL except for MODERATE adverse impacts on traffic	SMALL except for MODERATE adverse impacts on traffic	SMALL except for MODERATE adverse impacts on traffic	SMALL except for MODERATE adverse impacts on traffic	SMALL except for MODERATE adverse impacts on traffic
Environmental Justice	None[(c)]	None[(c)]	None[(c)]	None[(c)]	None[(c)]
Historic and Cultural Resources	MODERATE	MODERATE	SMALL	MODERATE	SMALL
Air Quality					
Criteria pollutants	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Greenhouse gas emissions	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
Nonradiological Health	SMALL	SMALL	SMALL	SMALL	SMALL
Radiological Health	SMALL	SMALL	SMALL	SMALL	SMALL
Postulated Accidents	SMALL	SMALL	SMALL	SMALL	SMALL

(a) Cumulative impact determinations taken from EIS Table 7-3.
(b) Cumulative impact determinations taken from EIS Table 9-28.
(c) A determination of "NONE" for Environmental Justice analyses does not mean there are no adverse impacts on minority or low-income populations from the proposed project. Instead, an indication of "NONE" means that while there are adverse impacts, those impacts do not affect minority or low-income populations in any disproportionate manner, relative to the general population.

Table ES-3 provides a summary of the cumulative impacts for the proposed and alternative sites. The NRC staff concluded that all of the sites were generally comparable, and it would be difficult to state that one site is preferable to another from an environmental perspective. In such a case, the proposed site prevails because none of the alternatives is environmentally preferable to the proposed site.

Table ES-4 provides a summary of the EIS-derived impacts for a new nuclear power plant in comparison with the energy alternatives. The NRC staff concluded that none of the viable energy alternatives is preferable to construction of a new baseload nuclear power-generating plant located within FPL's region of interest.

The NRC staff considered various alternative systems designs, including seven alternative heat-dissipation systems and multiple alternative intake, discharge, and water-supply systems. The review team identified no alternatives that were environmentally preferable to the proposed Turkey Point Units 6 and 7 systems design.

Figure ES-2. Location of Sites Considered as Alternatives to the Turkey Point Site

Table ES-4. Summary of Environmental Impacts[(a)] of Construction and Operation of New Nuclear, Coal-Fired, and Natural-Gas–Fired Generating Units and a Combination of Alternatives

Impact Category	Nuclear	Coal[(b)]	Natural Gas[(b)]	Combination of Alternatives[(b)]
Land Use	MODERATE	MODERATE	MODERATE	MODERATE
Air Quality	SMALL	MODERATE	SMALL to MODERATE	SMALL to MODERATE
Water Use and Quality	SMALL	SMALL	SMALL	SMALL
Ecology	MODERATE	MODERATE	MODERATE	MODERATE
Waste Management	SMALL	MODERATE	SMALL	SMALL
Socioeconomics	MODERATE Beneficial to MODERATE Adverse	MODERATE Beneficial to MODERATE Adverse	MODERATE Beneficial to SMALL Adverse	MODERATE Beneficial to MODERATE Adverse
Human Health	SMALL	SMALL	SMALL	SMALL
Historic and Cultural Resources	MODERATE	MODERATE	MODERATE	MODERATE
Environmental Justice	NONE[(b)]	NONE[(b)]	NONE[(b)]	NONE[(b)]

(a) Impact levels for all alternatives are for construction and operation but do not reflect cumulative impacts. Thus, the nuclear impacts identified here may differ from those used to compare the proposed site to the alternative sites, which reflect cumulative impacts.
(b) Impacts taken from EIS Table 9-4. These conclusions for energy alternatives should be compared to NRC-authorized activities reflected in Chapters 4, 5, and Sections 6.1, and 6.2.
(c) A determination of "NONE" for Environmental Justice analyses does not mean there are no adverse impacts to minority or low-income populations from the proposed project. Instead, an indication of "NONE" means that while there are adverse impacts, those impacts do not affect minority or low-income populations in any disproportionate manner, relative to the general population.

Benefits and Costs

The NRC staff compiled and compared the pertinent analytical conclusions reached in the EIS. It gathered all of the expected impacts from building and operating proposed Turkey Point Units 6 and 7 and aggregated them into two final categories: (1) expected environmental costs and (2) expected benefits to be derived from approval of the proposed action. Although the analysis in Section 10.6 is conceptually similar to a purely economic benefit-cost analysis, which determines the net present dollar value of a given project, the purpose of the section is to identify potential societal benefits of the proposed activities and compare them to the potential internal (i.e., private) and external (i.e., societal) costs of the proposed activities. In general, the purpose is to inform the COL process by gathering and reviewing information that demonstrates the likelihood that the benefits of the proposed activities outweigh the aggregate costs.

On the basis of the assessments in this EIS, the building and operation of proposed Turkey Point Units 6 and 7, with mitigation measures identified by the review team, would accrue benefits that most likely would outweigh the economic, environmental, and social costs. For the NRC-proposed action (i.e., NRC-authorized construction and operation), the accrued benefits would also outweigh the costs of preconstruction, construction, and operation of proposed Turkey Point Units 6 and 7.

Public Involvement

A 60-day scoping period was held from June 15, 2010, to August 16, 2010. On July 15, 2010, the NRC held two public scoping meetings in Homestead, Florida. The review team received many oral comments during the public meetings and 32 e-mails and 10 letters throughout the rest of the scoping period on numerous topics including energy alternatives, terrestrial ecology, ground and surface water, and socioeconomics. The review team's response to the in-scope public comments can be found in Appendix D. The Scoping Summary Report (Agencywide Documents Access and Management System (ADAMS) Accession No. ML103130609) contains all of the comments, even those considered out-of-scope (e.g., security, safety issues).

During the initial 75-day comment period on the draft EIS, which began on March 6, 2015, the review team held public meetings in Miami, Florida, on April 22, 2015, and in Homestead, Florida, on April 23, 2015. During the course of the comment period, the NRC received requests from members of the public, a Tribal government, and Federal agencies to extend the comment period. In response to these requests, the NRC reopened the comment period on the draft EIS on May 28, 2015, until July 17, 2015, allowing additional time for public comments. In total, approximately 68 people provided oral comments at the public meetings held in April, and the NRC received approximately 11,300 pieces of correspondence during the original and reopened comment period.

Recommendation

The NRC's recommendation to the Commission related to the environmental aspects of the proposed action is that the COL should be issued.

This recommendation is based on the following:

- the application, including the ER, submitted by FPL
- consultation with Federal, State, Tribes, and local agencies
- site audits and alternative sites audits
- consideration of public comments received during the environmental review
- the review team's independent review and assessment summarized in this EIS.

The NRC's determination is independent of the USACE's determination of whether to issue, deny, or issue with modifications the DA permit application for the Turkey Point Units 6 and 7. The USACE will conclude its Clean Water Act Section 404(b)(1) Guidelines and public interest analyses in its Record of Decision.

5.0 OPERATIONAL IMPACTS AT THE TURKEY POINT SITE

This chapter examines environmental issues associated with the operation of proposed Units 6 and 7 at the Turkey Point Nuclear Power Plant (Turkey Point) site for an initial 40-year period as described by Florida Power & Light Company (FPL). As part of its application for combined construction permits and operating licenses (COLs), FPL submitted an Environmental Report (ER) that discussed the environmental impacts of plant operation (FPL 2014-TN4058). The U.S. Nuclear Regulatory Commission (NRC) staff, its contractor staff, and U.S. Army Corps of Engineers (USACE) staff (hereafter referred to as the "review team") independently evaluated information presented in FPL's ER (FPL 2014-TN4058) and supplemental documents, FPL responses to NRC Requests for Additional Information (RAIs), FPL's Site Certification Application (SCA) submitted to the Florida Department of Environmental Protection (FDEP) (FPL 2010-TN272), the FDEP review of the proposed project (State of Florida 2014-TN3637), USACE permitting documentation, as well as other government and independent sources.

This chapter is divided into 13 sections. Sections 5.1 through 5.11 discuss the potential operational impacts on land use, water, terrestrial and aquatic ecosystems, socioeconomics, environmental justice, historic and cultural resources, meteorology and air quality, nonradiological health, radiological health, nonradioactive waste, and postulated accidents. Section 5.12 discusses measures and controls that would limit the adverse impacts of station operation during the 40-year operating period. In accordance with Title 10 of the *Code of Federal Regulations* Part 51 (10 CFR Part 51) (TN250), impacts have been analyzed and a significance level of potential adverse impacts (i.e., SMALL, MODERATE, or LARGE) has been assigned by the review team to each impact category. In the area of socioeconomics related to taxes, the impacts may be considered beneficial and are stated as such, as appropriate. The review team's determination of significance levels is based on the assumption that the mitigation measures identified in the ER or activities planned by various State and County governments, such as infrastructure upgrades, as discussed throughout this chapter, are implemented. Failure to implement these upgrades might result in a change in significance level. Possible mitigation of adverse impacts is also presented, where appropriate. A summary of these impacts is presented in Section 5.13.

5.1 Land-Use Impacts

This section provides information about the land-use impacts associated with operation of proposed Units 6 and 7. Section 5.1.1 discusses land-use impacts at the site and in the vicinity. Section 5.1.2 discusses land-use impacts at offsite transmission line corridors and associated offsite facilities. Section 5.1.3 summarizes the land-use impacts.

5.1.1 The Site and Vicinity

The sections below address land-use impacts from operation of Units 6 and 7 facilities on the Turkey Point site and vicinity.

5.1.1.1 Onsite Land-Use Impacts

Permanent facilities in the 218 ac plant area would include the Units 6 and 7 power blocks, cooling towers and makeup-water reservoir, Clear Sky substation, and associated infrastructure (FPL 2014-TN4058). Outside of the plant area but still on the Turkey Point site, permanent facilities would include the FPL reclaimed water-treatment facility (RWTF), reclaimed water pipelines, radial collector wells (RCWs) and pipelines, nuclear administration and training buildings, parking areas, laydown areas, expanded equipment barge-unloading area, security buildings, heavy-haul road improvements, transmission infrastructure, sanitary-waste pipelines, potable-water supply pipelines, access road improvements, and the spoils areas. Table 4-1 lists each element of the proposed project and the land that would be dedicated to each. As noted in Section 4.1.1.1, the review team is assuming for purposes of analysis that all of the land dedicated to the project would be permanently dedicated.

Because the land dedicated to the project would remain occupied by plant-related facilities throughout the operational life of Units 6 and 7, the review team expects that the land dedicated to the project would not be available for unrelated land uses over that time. However, below-grade facilities such as pipelines may have only limited permanent land-use impacts, because they are underground and, in most places, the land at grade could be used for certain other unrelated uses (e.g., parking or storage). This is discussed in more detail below for specific facilities. FPL states that former construction laydown areas would be permanently dedicated to the project over its operational life and may be used during operations (FPL 2014-TN4058). The review team therefore assumes that these areas would not be available for non-project-related land uses throughout the operational life of Units 6 and 7.

Because the Units 6 and 7 facilities would be built mostly in previously undeveloped lands away from other concentrated areas of development, the review team expects that operation of the Units 6 and 7 and associated facilities would not affect or interfere with other land uses on the site or in the vicinity. Units 6 and 7 would be situated near other power-generation facilities (Units 1 through 5). Therefore, operation of the proposed new units would not represent a substantial change in land-use characteristics. While some land uses in the vicinity could be sensitive to the specific effects of the operation of a nuclear power plant, those effects are addressed in other sections of this environmental impact statement (EIS) related to aesthetics, recreation, and traffic (all in Section 5.4); salt deposition and fogging from cooling-tower operation (Section 5.7); and ecology (Section 5.3). These effects do not however suggest a potential for substantial land-use inconsistencies. As described in Section 2.2, land in the vicinity is predominantly wetlands and forestland (FPL 2014-TN4058) and includes several environmentally protected areas designated by the Miami-Dade County Comprehensive Development Master Plan (Miami-Dade County 2012-TN1150), as well as several areas of public land. The review team's evaluation of potential ecological impacts (Section 5.3) does not suggest any serious land-use conflicts with environmentally protected areas. Agricultural land composes approximately 4.5 percent (approximately 2,858 ac) of the land within the vicinity (Table 2-3). The review team expects because the proposed new facilities would be sufficiently isolated from these agricultural lands that would prevent substantial conflicts with nearby agricultural use.

Zoning and Consistency with Land-Use Plans

As addressed in Section 4.1, the Miami-Dade County Comprehensive Development Master Plan (Miami-Dade County 2012-TN1150) land-use designation for the location of proposed Units 6 and 7 is *Environmental Protection, Subarea F*. Electrical generation and transmission facilities are among the land uses described as being consistent with this designation.

The 218 ac plant area and most of the surrounding land on the Turkey Point site is zoned as GU (Interim District), with the exception of the land occupied by existing Turkey Point Units 1 through 5 and the area north of the plant area, which are zoned as IU-3 (Industrial, Unlimited Manufacturing District) areas. The GU zoning district allows for nuclear reactors, provided that approval by Miami-Dade County of an *Unusual Use* for the site is obtained. FPL applied for *Unusual Use* approval for Units 6 and 7 from Miami-Dade County, which was granted in Resolution No. Z-56-07 (Miami-Dade County 2007-TN1085) by the Miami-Dade Board of County Commissioners in December 2007. No additional changes to land use within the Turkey Point site are proposed or required for operation of Units 6 and 7.

Mineral Resources

As stated in Section 2.2, there are no known oil or gas wells or any sand or rock mining located within the Turkey Point site boundary. Thus, the review team finds that operation of the proposed project would cause no impacts on oil, gas, or mineral resources.

Prime and Unique Farmland

There is no prime or unique farmland, or farmland of State or local importance, as defined in the Farmland Protection Policy Act (7 U.S.C. § 4201 et seq.) (TN708) on the Turkey Point site (USDA 2012-TN1314). No impacts on special status farmland are therefore expected. Operational activities on the site are not expected to affect agricultural operations.

Coastal Zone Consistency

The Florida Coastal Management Act (Fla. Stat. 28-380-TN1147) authorizes the Coastal Zone Management Section of the FDEP to certify consistency with the Florida Coastal Management Program for all Federal licenses, permits, activities, and projects, when such activities affect land or water use. The Site Certification issued by the State of Florida on May 19, 2014 constitutes the State's concurrence that the licensed activity or use is consistent with the Federally approved program under the Florida Coastal Management Act.

Comprehensive Everglades Restoration Plan

Operating the Units 6 and 7 facilities after they are built is not expected to substantially interfere with the objectives or implementation of the CERP.

5.1.1.2 Pipelines

Land that would be used for the below-ground reclaimed water pipelines is identified in Figure 2-5 (FPL 2014-TN4058). Maintenance access by Miami-Dade County or FPL during operations would be accomplished on public roads or through access agreements with adjacent landowners. Because the pipelines would be easily accessible from roadways, maintenance and repair activities are not likely to interfere with adjacent land uses. Once built, the RCW caissons and pumping station would require periodic maintenance. Because these facilities would be located below ground, land uses of the offsite land area or Biscayne Bay would not be substantially affected. Impacts on other resources are addressed in other chapters of this EIS.

5.1.1.3 Access Roadways

As described in Section 3.3, the proposed project includes road improvements for operational access. The proposed improvements include widening three existing roadways and upgrading existing unpaved roads to establish new paved roadways (FPL 2014-TN4058).

FPL has indicated that roadway improvements installed during development of proposed Units 6 and 7 may not be needed for operations and could be removed to accommodate future land-use demands, although this is not specifically proposed (FPL 2014-TN4058). If roadway improvements were to be removed by FPL, FPL states that it would remove previous building materials, maintain historical hydrology, and regrade to previous contours (FPL 2014-TN4058).

5.1.2 Transmission Line Corridors and Associated Offsite Areas

5.1.2.1 Transmission Line Corridors

The following subsection addresses operations within the transmission line corridors and at substations.

The land proposed for use as transmission line corridors for proposed Units 6 and 7 is described in Section 2.2.2.

FPL has indicated that it would acquire land or easements as necessary to establish the proposed transmission line rights-of-way and would restrict incompatible uses in the rights-of-way during operation of the transmission lines (FPL 2014-TN4058). FPL requires that land uses in rights-of-way be compatible with the safe and reliable transmission of electricity. In areas that are in active agricultural cultivation, FPL typically allows farmers to grow feed for livestock and tree crops within the transmission line rights-of-way, subject to height limitations for vegetation and operation (FPL 2014-TN4058). FPL's standard rights-of-way vegetation management and line-maintenance programs would be followed to maintain the rights-of-way and transmission lines (FPL 2014-TN4058). These programs include requirements for use of herbicide application according to Federal, State, and local regulations. In addition, FPL states that environmental Best Management Practices (BMPs) would be used to reduce soil erosion and sedimentation, and that vegetation management in forested wetlands would comply with Fla. Stat. 29-403.814-TN1259, General Permits.

Local communities have raised concerns about the visual impacts and potential indirect blight impacts as a result of FPL's proposed location of the transmission lines (State of Florida 2012-TN1248; State of Florida 2011-TN1260; State of Florida 2011-TN1261). In addition, the National Park Service (NPS) has expressed concerns about aesthetics and land-use effects of locating transmission lines near the Everglades National Park (NRC 2010-TN516).

During scoping for this EIS, local agencies expressed concerns about potential interference with local agency radio operations. While effects are largely dependent on tower height and signal frequency, because all radio frequencies in the FM range are higher than the frequency emitted by the lines and because the effect would diminish very quickly with distance, interference would be unlikely to occur (Exponent 2012-TN3710).

5.1.2.2 Substations

As described in Section 4.1, FPL has stated that building and/or expansion of several substations would meet applicable environmental regulatory requirements for their development and operation. Thus, the review team finds that operation of the proposed expanded substations (the Turkey Point, Levee, Davis, and Pennsuco substations) would be compatible with existing land uses near the substations (power generation, tree nurseries, and rock quarries).

5.1.3 Summary of Land-Use Impacts

The effects on land-use resulting from operation of proposed Turkey Point Units 6 and 7 would be minimal because the land to be used for operations is land that has been previously disturbed to build the new facilities. Operation and maintenance of permanent site-access roadways and pipelines would be compatible with the current land uses and would not affect any existing or planned land uses.

Operation and maintenance of transmission lines would also be generally compatible with the current land uses and would not affect any existing or planned land uses. However, Miami-Dade County and cities within the county have raised issues related to the aesthetic compatibility of parts of the proposed new transmission lines with some urban areas. In addition, NPS has raised compatibility questions regarding where parts of the proposed transmission lines would be situated close to or adjacent to Everglades National Park.

Based on information provided by FPL and the review team's independent review, the review team concludes that the land-use impacts associated with operation of Units 6 and 7 would be MODERATE. The MODERATE conclusion primarily reflects the compatibility of portions of the transmission lines with adjacent land uses.

5.2 Water-Related Impacts

This section discusses water-related impacts on the surrounding environment from operation of proposed Turkey Point Units 6 and 7. Details of the operational modes and cooling-water systems associated with operation of the proposed units are discussed in Section 3.2.2.2.

Managing water resources requires understanding and balancing the tradeoffs between various, often conflicting, designated uses. At the site of the proposed Turkey Point Units 6 and 7, FDEP designates Biscayne National Park as an Outstanding Florida Water, meaning there is to be no degradation of its water quality (FDEP 62-302.400(14) and FDEP 62-302.700(9)(a)1) (Fla. Admin. Code 62-302-TN776). The canals in the area (constructed before November 28, 1975) are evaluated based on the limited aquatic life support and habitat limits of these waters (FDEP 62-302.400(4) [TN776]). The designated uses include navigation, recreation, visual aesthetics, fisheries, and consumptive water uses. The responsibility for any work in, over, or under navigable waters of the United States is delegated to the USACE. The FDEP is responsible for protecting and restoring the quality of Florida water, air, and land resources, and the Florida Department of Community Affairs is responsible for determining that projects are consistent with Florida's Coastal Management Program (FDEP 2012-TN1544).

Water-use and water-quality impacts involved with operation of a nuclear plant are similar to the impacts associated with the operation of any large thermoelectric power-generation facility. Accordingly, FPL must obtain the same water-related permits and certifications as any other large industrial facility. These include the following:

- Clean Water Act (CWA) (33 U.S.C. § 1251 et seq.) (TN662) - Section 401 is at 33 U.S.C. § 1341 (TN4764) Certification. This certification is issued by the FDEP as part of Florida's Power Plant Siting Act Certification (Fla. Stat. 29-403.501 2011-TN1068) and ensures that the project does not conflict with State water-quality standards. This certification is required before the NRC can issue a COL to FPL. Florida issued the final Order of Certification on May 19, 2014 (State of Florida 2014-TN3637). If a Department of the Army permit is issued, the 401 Water Quality Certification would be required in addition to a Coastal Zone Consistency Determination both of which are provided by the State of Florida.
- Department of the Army Permit. Authorization from the USACE would be required under CWA Section 404 (33 U.S.C. § 1344) (TN1019) for the discharge of dredge or fill material into waters of the United States associated with the site-preparation activities and construction of the nuclear power plant and its associated components. Authorization would also be required under Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. § 403) (TN4768) for the construction of structures or work in, under, or over navigable waters of the United States associated with the construction of the nuclear power plant and its associated components. The USACE will conclude its Clean Water Act Section 404(b)(1) Guidelines and public interest analysis for this permit decision in its Record of Decision. Furthermore, Section 14 of the Rivers and Harbors Act (33 U.S.C. § 408) (TN4769) requires authorization for any components of the project that would in any way impair the usefulness of a USACE Civil Works Project; a separate 408 review will be conducted to ensure the will be no inconsistency with the intended use that was authorized by Congress.
- Clean Water Act (33 U.S.C. § 1251 et seq.) (TN662) - Section 402 is at 33 U.S.C. § 1342 (TN4765) National Pollutant Discharge Elimination System (NPDES) permit. This permit would regulate limits of pollutants in liquid discharges to surface water. The U.S. Environmental Protection Agency (EPA) has delegated the authority for administering the NPDES program in Florida to the FDEP. The NPDES permits are part of Power Plant Siting Act certification. A stormwater pollution prevention plan (SWPPP) for construction would also be required.
- Water-use permit. Consumptive use of surface water or groundwater would require a permit from the FDEP or the water-management district.
- Groundwater well drilling and operating permits. Construction of water wells would require a permit from the South Florida Water Management District (SFWMD).
- FDEP Class I Industrial Waste Underground Injection Control Permits (Fla. Admin. Code 62-528-TN556). Underground Injection Control (UIC) wells are required to be constructed,

maintained, and operated so that the injected fluid remains in the injection zone, and the unapproved interchange of water between aquifers is prohibited. Class I injection wells are monitored so that if migration of injection fluids were to occur it would be detected before reaching the underground source of drinking water (USDW).

5.2.1 Hydrological Alterations

The staff assessed the following potential hydrological alterations associated with the operation of Units 6 and 7 and the resulting effects on the environment:

- Operation of RCWs under Biscayne Bay for use as a backup supply of cooling water that would remove water from Biscayne Bay, the industrial wastewater facility (IWF), and the Biscayne aquifer.
- Use of potable and service water for the proposed units that would be obtained from the existing Miami-Dade Water and Sewer Department (MDWASD) water supply, which comes from the Biscayne aquifer in Miami-Dade County.
- Injection of station blowdown water and other liquid waste streams into the Boulder Zone—a cavernous, high-permeability South Florida geologic horizon located at depths of approximately 2,900 to 3,500 ft in the Lower Floridan aquifer.
- Deposition of drift from Units 6 and 7 cooling towers, including associated salt and chemical contaminants, onto nearby aquatic and terrestrial systems. With the use of reclaimed water as the cooling-tower water supply, chemical contaminants could be present in the cooling-tower water and drift. With the use of the Biscayne Bay as a backup supply of water (via the RCWs), salt deposition could occur on terrestrial and aquatic systems.
- Stormwater runoff from buildings, pavement, and RWTFs, and accompanying changes in the quality of runoff water from the spoils disposal area.

The following water resources are of primary interest for the review of hydrologic alterations:

- Biscayne Bay;
- Biscayne aquifer;
- Boulder Zone;
- IWF (cooling canals); and
- water resources on offsite/adjacent areas.

In the summer of 2014, the IWF experienced elevated temperatures, elevated salinities, elevated algae, and decreased water-surface elevations (see Section 2.3.1.1, Industrial Wastewater Facility). As discussed in Section 2.3.1.1, in response to these changes water was pumped into the canals from the Biscayne aquifer, Upper Floridan aquifer (also called the UFA), and the L-31E Canal. Continued actions are planned and the review team considered the consequence of the possible changes for the future affected environment.

The staff determined the only plausible change to the draft EIS impact assessment would be from the operation of the RCW. The review team identified no plausible significant changes in impacts from the operation of Units 6 and 7 under reclaimed water operation because the operation does not withdraw water from the Upper Floridan aquifer, the Biscayne aquifer, or

Biscayne Bay. As discussed Section 3.1, the AP1000 reactor design does not rely on either the reclaimed water supply or the RCWs to shut down safely.

Neither the conditions observed in the IWF in the summer of 2014 nor the subsequent response by FPL changed the review team's understanding of the current affected environment. However, future plans (see Section 2.3.1.1, Industrial Wastewater Facility) would change the affected environment in ways that were not explicitly discussed in the draft EIS. For instance, continued freshening of the cooling canals with water from wells in the Upper Floridan aquifer and the Biscayne aquifer, and withdrawals from the L-31E Canal may result in a sustained higher water-surface elevation and lower salinity in the IWF than observed during 2014 through 2015. In addition, efforts to retract the hypersaline plume to beneath FPL's property boundary would alter water pressures in the Biscayne aquifer and result in a general reduction of the salinity of groundwater in the Biscayne aquifer on the Turkey Point site.

Neither the exact design of systems for implementing either of the above actions nor their efficacy is fully known. Therefore, the review team considered a broad range of future conditions to determine if they might change the minimal incremental impact of the operation of the RCWs discussed in the EIS. The review team evaluated the hydrological alterations and their potential effects on the above-mentioned resources as discussed below.

5.2.1.1 Biscayne Bay

Hydrological alterations that may affect Biscayne Bay due to the operation of proposed Turkey Point Units 6 and 7 include (1) RCW operation, (2) drift deposition, and (3) stormwater runoff.

Effect of Radial Collector Well

To evaluate the effect of RCW pumping on salinity in Biscayne Bay, the U.S. Geological Survey (USGS), in conjunction with NRC conducted a numerical modeling study of the Biscayne Bay-Biscayne aquifer system (NRC 2014-TN3078; Appendix G). The model used for this study is a three-dimensional surface and groundwater model and was derived from a previously developed and calibrated model of the Biscayne aquifer and Biscayne Bay (Lohmann et al. 2012-TN1429). The NRC contracted with the USGS to modify the model to include the proposed RCWs, the IWF, and a dewatering well used during the building of proposed Units 6 and 7. The model incorporates tidal exchange with the Atlantic Ocean and freshwater inflows from canals and groundwater. The model was calibrated to groundwater heads, canal base flows, and the location of the saltwater-freshwater interface, salinity, and temperature in Biscayne Bay. The calibration period covered a 9-year simulation period from 1996 through 2004. The USGS prepared an administrative report (NRC 2014-TN3078) that documents the modeling analysis, which includes the effects of operating the RCW pumping on the surface and groundwater system. The review team summarized this administrative report, which is provided in Appendix G of this EIS.

The base case and all scenario model runs were made for a simulation period from 1996 through 2004 (the calibration period), during which time the effects of RCW pumping were examined via the differences in results for piezometric head and salinity. The base case was derived from the calibrated model with the addition of the cooling canals of the IWF and the wells used for dewatering of the plant area during building. The two dewatering wells were set to pump for a 6-month period (June 2001 through December 2001 of the simulation period) with a maximum pumping rate of 98,320 m^3/d) (9,128 gpm). The scenarios were derived from the base case with the addition of the RCWs. The USGS analysis (NRC 2014-TN3078) examined several RCW pumping scenarios, but the review team used the continuous-pumping scenario for its examination because it provided the most conservative analysis of the effects of the RCW operations. Continuous pumping is the most conservative scenario because it allows no time for the groundwater system to recover from RCW pumping.

Much of the assessment of RCW pumping used by the review team was based on the salinity time-series analyses provided by the USGS analysis of model results (NRC 2014-TN3078). However, the review team conducted additional analyses of the model results, which included examination of salinity time series at locations in Biscayne Bay in addition to those examined by the USGS (NRC 2014-TN3078). These additional locations were close to and north of Turkey Point (Appendix G, Figure G-5). The review team was also interested in examining the spatial distribution of salinity and salinity differences in Biscayne Bay produced by RCW pumping. The review team selected two dates that had either a relatively large salinity increase or a relatively large salinity decrease between the continuous-pumping scenario and the base case. The relatively large salinity increase occurred on 10/3/2003, while the relatively large salinity decrease occurred on 10/25/2004. The plot of the time series of salinity differences shown in Figure G-9 in Appendix G indicates these dates.

The review team's examination of salinity time series indicated that the salinity difference between the continuous pumping scenario and the base case was mostly within ±1 psu, with only transient increases to near 2 psu (Appendix G, Figure G-9). The review team examined the spatial distribution results on the date of a large increase (10/3/2003) and found the largest increases were less than about +2.3 psu. Also, the salinity increases greater than +1 psu occurred in a relatively small area (14.4 km^2 [5.57 mi^2]) located north of Turkey Point (Appendix G, Figure G-8); the maximum salinity within this area was about 30.8 psu. The review team examined the spatial distribution results on a date of a large salinity decrease and found salinity decreases less than -1 psu occurred in an area that was 24.2 km^2 (9.33 mi^2) in size located north of Turkey Point (Appendix G, Figure G-10); the maximum salinity within this area was about 31.8 psu. Overall, these results show that the temporal and spatial variation of salinity with continuous RCW pumping was minimal. The review team notes that the actual duration of pumping will not be continuous. As required by the FDEP Conditions of Certification (COCs; State of Florida 2014-TN3637), operation of the radial wells is to be limited to 60 days or less per year. This short duration of pumping will allow time for the groundwater system to recover after any pumping from the RCW and will limit the entrainment of saltwater and reduce alterations of salinity patterns within Biscayne Bay. Therefore, the effect on Biscayne Bay salinity of any permitted pumping would be much reduced from the already minimal salinity change found by the review team in the USGS modeling analyses for a continuous-pumping scenario. The NRC staff is aware that on April 20, 2016, a Florida court, (State of Florida 2016-TN4781) remanded the Conditions of Certification to the Florida Siting Board insofar as the COCs relate to proposed transmission lines and associated mitigation measures in the East Everglades. The remand, however, did not require reconsideration of the COCs related to operation of the RCWs. Accordingly, the original COC limiting RCW operation to 60 days per year remains undisturbed. Even if the COCs related to RCW operation are revisited, the review team considers it reasonable to expect that Conditions of Certification similar to or no less effective than those originally issued in regard to RCW operation will be in place before construction and operation of the proposed units begins.

Effect of Drift Deposition

While using treated reclaimed water as the source for makeup water, FPL would operate the cooling system to achieve four cycles of concentration (FPL 2014-TN4058). While using the RCWs (Biscayne Bay saltwater) as the source for makeup water, the system would operate at 1.5 cycles of concentration. Any residual contaminants in the treated reclaimed water and the chemical constituents of saltwater could be concentrated in the cooling-water system due to evaporative losses during cooling, although any individual contaminant could also have losses due to volatilization and environmental decay, thereby decreasing the concentration.

Small droplets of water (drift) and salt particles would be emitted from the cooling towers during operation. For the Turkey Point Units 6 and 7 combined drift rate from the circulating-water system and service-water system towers the expected maximum drift rate would be approximately 8 gpm (Table 3-6). As a result, salt along with any potential contaminants in the cooling water could be deposited on the area surrounding the cooling towers. When using treated reclaimed water for makeup water, priority pollutants and contaminants of emerging concern (CECs) could be contained in the drift. When using the RCWs, priority pollutants contained in seawater could occur in drift. Section 2.3.3.1 lists concentrations of contaminants that were detected in Biscayne Bay.

The review team has conducted analyses to estimate drift deposition of chemical contaminants on aquatic and terrestrial habitats. Four general categories of chemical constituents are included in the drift-deposition analysis: general water chemistry (e.g., total dissolved solids [TDS]), metals (e.g., copper), volatile organic compounds (VOCs; e.g., 1,4-dichlorobenzene), and CECs (e.g., 4-nonylphenol). The constituent TDS concentration increases in the cooling water by evaporation due to operation of the cooling towers. The high concentration of TDS in the cooling water results in drift with a high concentration of TDS. Evaporation of the water in the drift results in salt particles, which are deposited in the area surrounding the cooling towers. The other constituents (metals, VOCs, and CECs) are assumed to be carried with the drift particles in the same ratio as in the source water.

The EPA (2012-TN1018) identifies CECs as previously undetected chemicals in water or chemicals that are detected at concentrations different than expected, and for which human health and environmental risks are unknown or poorly known.

The estimated drift-deposition rates are used for determining aquatic and terrestrial ecological effects. The specific habitats examined include the cooling canals of the IWF, nearshore Biscayne Bay, and terrestrial areas west of the proposed Units 6 and 7 cooling towers. The potential concern for the cooling canals, while not a water body regulated for water quality, is related to the potential impact on the Federally protected crocodiles, which nest on the cooling-canal berms at several locations at the IWF. For Biscayne Bay, the concern relates to the designation by FDEP of Biscayne National Park as an Outstanding Florida Water (FDEP 2010-TN156).

The review team independently estimated drift deposition with the use of makeup water from reclaimed water and from Biscayne Bay water. Drift deposition is determined by the flow rate through the cooling towers and TDS concentration of the cooling water—higher TDS concentration produces higher deposition rates. The review team used the CALPUFF model to independently compute drift-deposition rates from the cooling towers. Using the total drift deposition of salt computed from CALPUFF for both reclaimed wastewater and Biscayne Bay marine water, the review team estimated the salt deposition and the associated drift deposition for representative chemical contaminants. The review team assumed that the ratio of contaminant concentration to TDS concentration was the same in the cooling-tower water as it was in the makeup water supplied by Miami-Dade County to FPL, including an adjustment for cycles of concentration. This conservative approach assumes no loss of contaminants via removal at FPL's RWTF, biodegradation, or volatilization. This conservative approach provides the worst case of loading via drift deposition from the cooling towers. It includes the assumption of increased concentration with increased cycles of concentration.

The TDS for makeup water derived from the reclaimed water source is expected to be 680 mg/L, which the review team calculated from Miami-Dade wastewater TDS concentrations and then assumed four cycles of concentration for estimating the drift concentrations. For saltwater, the makeup-water TDS concentration used was approximately 34,300 mg/L (FPL 2012-TN263) with a drift concentration assuming 1.5 cycles of concentration. The review team assumed there was no alteration of salinity from treatment.

To evaluate the potential effects of cooling-tower deposition on the aquatic resources of Biscayne Bay, the review team first performed a screening-level assessment to identify chemicals and constituents likely to occur at ecologically relevant concentrations in both reclaimed water and Biscayne Bay seawater obtained from the RCW system. As stated above, four general categories of chemical constituents were included in the initial screen: general water chemistry (e.g., TDS), metals (e.g., copper), organic compounds (e.g., 1,4-Dichlorobenzene, phenanthrene), and CECs) commonly found in pharmaceuticals, personal care products, and other consumer products. Likely concentrations in reclaimed water and Biscayne Bay seawater were obtained from technical data provided by FPL (2012-TN263), a study by Lietz and Meyer (2006-TN1005) on CECs from the Miami-Dade South District Wastewater Treatment Plant (SDWWTP), and information available in a 2011 study by the Biscayne Bay Coastal Wetlands Rehydration Pilot Project (Miami-Dade County 2011-TN1006). Detected concentrations of general water chemistry parameters (Section 2.3.3.1), organic compounds, and metals were compared to existing EPA freshwater and marine water-quality criteria, which are readily available for many compounds and believed to be protective of aquatic life. Compounds exceeding established water-quality criteria were retained in the screening-level assessment for fate and effects modeling. For chemicals lacking established water-quality criteria, such as many CECs, detected concentrations in reclaimed or Biscayne Bay water were compared to toxicological benchmarks available on EPA's ECOTOX (Ecotoxicology) Database (EPA 2012-TN1525). Chemicals present at >1/10 of a benchmark were retained in the screen and included in fate and effects modeling, as described in Section 5.3.2. Table 5-1 presents the review team's estimated drift-deposition rates for these compounds for three separate areas: the cooling canals of the IWF, adjacent areas west of the IWF, and Biscayne Bay. Compounds included for fate and effects analysis in the cooling canals included nine CECs and one metal. Constituents identified in Biscayne Bay seawater at levels above EPA criteria included only chlorides and sulfides. Areas west of the IWF were examined only for deposition rate and are considered in terrestrial ecology sections (Section 5.3.1).

Table 5-1. Estimated Annual Average Deposition Rates from Cooling-Tower Drift

Constituent Concentrations			Review Team-Estimated Annual Average Drift-Deposition Rates		
Constituent	**Category**	**Concentration (μg/L)**	**Cooling Canals (g/m^2-yr)**	**Western Areas/Model Lands (g/m^2-yr)**	**Biscayne Bay (g/m^2-yr)**
Reclaimed Water					
TDS	Wastewater	680,000[(a)]	0.34	0.18	0.082
1,4-Dichlorobenzene	Insect repellant	1.3[(a)]	6.6×10^{-7}	3.4×10^{-7}	1.6×10^{-7}
3 Beta-coprostanol	Human digestion	2[(b)]	1.0×10^{-6}	5.2×10^{-7}	2.4×10^{-7}
4-Nonylphenol	Detergent metabolite	4[(b)]	2.0×10^{-6}	1.0×10^{-6}	4.8×10^{-7}
Acetyl-hexamethyl-tetrahydro-naphthalene (AHTN)	Polycyclic musk (e.g., tonalide)	4[(b)]	2.0×10^{-6}	1.0×10^{-6}	4.8×10^{-7}
Hexahydrohexa-methylcyclo-pentabenzopyran (HHCB)	Polycyclic musk (e.g., galaxoide)	0.5[(b)]	2.5×10^{-7}	1.3×10^{-7}	6.1×10^{-98}
Phenanthrene	Polycyclic aromatic hydrocarbon (PAH) compound	0.6[(b)]	3.0×10^{-7}	1.5×10^{-7}	7.3×10^{-98}
Warfarin	Pharmaceutical	0.12[(b)]	6.1×10^{-8}	3.1×10^{-8}	1.5×10^{-8}
17 Beta-estradiol (E2)	Hormone	0.035[(b)]	1.8×10^{-8}	9.0×10^{-9}	4.2×10^{-9}
Triclosan	Antimicrobial	120 [(d)]	8.1×10^{-5}	4.1×10^{-5}	1.9×10^{-5}
Copper	Metal	9.6[(a)]	4.9×10^{-6}	2.5×10^{-6}	1.2×10^{-6}
Phosphorus	Nutrient	183[(e)]	$9.3 \text{ x } 10^{-5}$	$4.8 \text{ x } 10^{-5}$	$2.3 \text{ x } 10^{-5}$
Radial Collector Well Water					
TDS	Sea water	35,800,000[(a)]	6.1	3.1	1.6
Chloride	Sea water	20,700,000[(a)]	3.5	1.8	0.90
Sulfide	Sea water	8,000[(a)]	1.4×10^{-3}	7.0×10^{-4}	3.5×10^{-4}
Phosphorus	Nutrient	670[(e)]	$3.4 \text{ x } 10^{-4}$	$1.8 \text{ x } 10^{-4}$	$8.3 \text{ x } 10^{-5}$

(a) FPL 2012-TN263.
(b) Lietz and Meyer 2006-TN1005.
(c) Contaminant with lowest environmental effect concentration.
(d) Miami-Dade County 2011-TN1006.
(e) FPL 2014-TN4058.

The salt-deposition rates over the nearshore of Biscayne Bay are lower with the use of reclaimed water (0.0069 $g/m^2/mo$) than with the use of marine waters for Biscayne Bay obtained from the RCWs (0.1292 $g/m^2/mo$). With the use of either the reclaimed water or RCWs, the deposition rates of potentially associated chemical contaminants are extremely low. Only TDS, chloride, and sulfide have deposition rates greater than 10^{-6} $g/m^2/mo$, and chloride and sulfide naturally occur in marine waters.

The review team considered the impact of contaminant drift deposition on Biscayne Bay by first examining the volumetric tidal exchange in the nearshore region of the Turkey Point site. The review team used the tidal elevation data from the Virginia Key station (NOAA 2012-TN1321) to compute the tidal range and volume change over the drift-deposition area in the CALPUFF model. (Because other National Oceanographic and Atmospheric Administration stations within Biscayne Bay had only limited historic data, they were not used.) The review team computed the average depth in this region to be 1.24 m and the median tidal range to be about 0.6 m. Using this tidal range and the computed volume in the nearshore region potentially affected by drift deposition, the review team calculated a median volumetric tidal exchange of 48 percent of the total nearshore volume. This means that almost half the volume is exchanged with each turn of the tide. Consequently, with the extremely low contaminant-deposition rates (Table 5-1) and high tidal exchange rate, contaminant concentrations from drift deposition in the water column would be too small to detect.

Effect of Stormwater Runoff

The site hydrology prior to construction is discussed in Section 2.3.1.1. Modifications to the land surface made during preconstruction and construction activities would alter the site hydrology, and these alterations would remain during plant operations. As discussed in Section 4.2.1.4, stormwater runoff from spoils areas, and nuclear administration and training buildings areas would be managed with environmental controls and directed to the IWF. Stormwater runoff from the RWTF area, except for the equipment area runoff, would be routed to stormwater management basins before being released to its surrounding wetland area. As discussed in Section 3.2.2.1, no direct stormwater discharges would be made to Biscayne Bay. Therefore, during operations, no noticeable effect of stormwater runoff in the hydrologic conditions of the Biscayne Bay is expected.

5.2.1.2 Biscayne Aquifer

Hydrological alterations affecting Biscayne aquifer that would be associated with the operation of Turkey Point Units 6 and 7 are the RCWs removing water from the aquifer beneath Biscayne Bay, and the additional demand for MDSWD-supplied potable water to meet the need for process and potable water. Removal of water by the RCWs is expected to (1) increase the velocity of water movement from the bay into the bed of the bay, (2) reduce aquifer hydraulic head within the aquifer under the bay, (3) influence aquifer hydraulic gradients in the vicinity of the hypersaline plume, and (4) change the water chemistry in sediments between the bay floor and the radial well laterals by increasing the flow of oxygenated water. These alterations to the groundwater flow system are described below.

Changes in the Velocity of Water Movement into the Bed of Biscayne Bay from Operation of the Radial Collector Wells

Water pumped by the RCWs will be drawn downward through the sediment and rock formations underlying Biscayne Bay and laterally through the more permeable zone where the well laterals are installed. The review team calculated that the vertical velocity of saltwater approaching the bay bottom would average 0.0003 ft/min (0.000152 cm/sec) or about 0.4 ft/d if all of the pumped water flowed homogeneously into the bay bottom within a polygon encircling the RCW laterals at the expected maximum flow rate of 86,400 gpm (327 m^3/min) (FPL 2014-TN4058). This assumption is conservative in that a large portion of the water is expected to move into the aquifer through the bay floor outside of the polygon and then move laterally through the aquifer to the wells. The review team estimated that the average vertical permeability of the aquifer confining layer is about 0.7 ft/d compared to 10,000 ft/d for the highly permeable portion of the aquifer (see Section 2.3 of the EIS). However, the approach velocity will vary laterally across the bay floor because of variations in the vertical permeability of the sediment and limestone that lie between the bay bottom and the permeable layer of the aquifer where the radial collector laterals will be placed. The review team analyzed a possible worst-case scenario for approach velocity by assuming that an enhanced vertical permeability flow path exists near the RCW laterals with a permeability of 1,000 ft/d, which is 1,428 times higher than the average vertical permeability. This results in a calculated maximum approach velocity of 0.43 ft/min at the enhanced vertical permeability feature. In reality, water pumped by the RCWs would likely infiltrate the bay bottom over a much larger area resulting in lower velocities.

Changes in Aquifer Hydraulic Head from Operation of the Radial Collector Wells

The RCWs installed under Biscayne Bay would pump saline groundwater from the Biscayne aquifer at a depth between 25 and 40 ft beneath the bay floor (Section 3.2.2). The review team determined that this pumping would reduce hydraulic head in the Biscayne aquifer resulting in flow of water from the overlying bay and from relatively permeable sediment layers that compose the Biscayne aquifer. Impacts on the inland portion of Biscayne aquifer are determined by the volume of water captured by the RCWs that comes from the inland portion of the aquifer compared to the volume that comes from the bay. Removing relatively large volumes of water from the inland aquifer could lower the water table in the inland portion of the aquifer, affecting existing water-supply wells and increasing saltwater intrusion to the Biscayne aquifer.

In regard to the Biscayne aquifer, saltwater from the sea has already intruded into the groundwater in the Biscayne aquifer in the vicinity of the Turkey Point site, which has resulted in elevated salinity in that groundwater. This saltwater intrusion from the sea is unrelated to operations at Turkey Point. Because of its elevated salinity, groundwater from the Biscayne aquifer in the vicinity of the Turkey Point site cannot be used as a drinking water source without treatment. Seepage of saline water from the IWF cooling canals associated with the existing Turkey Point Units 3 and 4 has also resulted in locally higher groundwater salinity near the cooling canals. Analyses from the USGS groundwater-surface water model presented in the EIS show that in the absence of remediation of the IWF hypersaline plume, increases in groundwater salinity may occur inland from Turkey Point because of movement of the existing hypersaline plume regardless of whether or not the proposed units are built and operated. The model-predicted increase in groundwater salinity is not caused by RCW pumping or other activities related to the proposed units. The model-predicted increase in groundwater salinity also does not reach the location of drinking water wells.

The review team determined that RCW drawdown effects are unlikely in the inland areas west and south of the IWF because the IWF cooling canals, the interceptor ditch, and the L-31E canal create hydraulic barriers that isolate the inland Biscayne aquifer from the RCWs. Effects on saltwater intrusion and inland wells in the Biscayne aquifer would also be reduced by the limitations on use of the RCWs, which is expected to be limited to 60 days per year, or less (FPL 2012-TN1262; State of Florida 2014-TN3637). The review team evaluated information about the reliability of the components of the reclaimed water system and determined that the RCW supply system would be called into use infrequently and for durations much shorter than 60 days. The NRC review team determined that there is a large volume of treated municipal wastewater that can be used for cooling the proposed plants without affecting the ability to meet demands for fresh water. Miami Dade Water and Sewer Department is required to direct 60 percent of the wastewater flows to reuse by 2025 and to cease using ocean outfalls by 2025 under the Florida State Ocean Outfall Legislation Compliance Plan (Miami Dade County 2013-TN4786). Therefore, the NRC staff concluded that the reclaimed water supply is reliable. The review team further determined that the primary reclaimed water source is reliable because of the reliability of the proposed reclaimed water-treatment facility and associated pipelines. Further, the review team also considered alternative sources of cooling water in EIS Section 9.4.2, none of which are environmentally preferable to the proposed sources of cooling water. In view of the high reliability of the reclaimed wastewater source and the availability of the RCW system as a backup, there is no need to consider additional backup sources of cooling water. If the RCWs are needed for a backup supply of water, the maximum pumping rate would be 86,400 gpm (327 m^3/min) (FPL 2014-TN4058). The minimum volume expected to be pumped per year for RCW maintenance and testing purposes would be a total of 40,000 gal (151.4 m^3).

The RCWs are designed so that nearly all the water comes from Biscayne Bay rather than from the inland aquifer because of the location of the RCW laterals a relatively short distance beneath the bay. However, the review team determined that the volume of water that would be removed from the inland aquifer is difficult to predict with certainty because it depends on several hydrogeologic features and parameters that are incompletely quantified. Water flowing to the RCWs from the bay must move through the bay floor or through permeable layers of the limestone bedrock exposed to seawater, either in the bay or at the continental shelf. As described in Section 2.3 the bottom of the bay consists of either sandy material, exposed rock, or a sandy muck. Areas of sand or sandy muck are usually signified by the presence of seagrass. However, the review team has observed that silty sediments are present in some areas of the Biscayne Bay floor near the proposed RCW location. These silty sediments could impede the downward flow of water from the bay to the laterals.

FPL used a local-scale groundwater flow model of the Biscayne aquifer to simulate the effects of construction dewatering and operational cooling-water withdrawals from proposed RCWs in sediments beneath Biscayne Bay. Results and details of the model configuration and calibration were provided in FPL's groundwater model report (FPL 2011-TN1440).

As described in Section 5.2.1.1, the USGS (2012-TN1441) also performed numerical modeling analysis of RCW operation to confirm the effect of RCW pumping on the Biscayne aquifer and Biscayne Bay. A detailed description of the USGS model is provided in Appendix G of this EIS. The review team used results from both of these models in its assessment of groundwater impacts at the Turkey Point site. However, neither of the models was the sole basis of the review team's assessment because such models are only an approximation of the real physical system.

According to FPL's groundwater modeling (FPL 2014-TN4069), the RCWs would draw produced water from Biscayne Bay (approximately 98 percent), the IWF cooling canals (approximately 2 percent), and the inland portions of the Biscayne aquifer (less than 0.3 percent) (FPL 2014-TN4058).

The USGS model also showed that nearly all of the water produced by the RCWs would come from Biscayne Bay with minor, seasonally variable, amounts of water coming from the inland portion of the Biscayne aquifer, from the IWF, and from nearby freshwater canals. The USGS model had a larger domain and included the effects of variable density fluid and changes in water levels at freshwater canals, which were ignored in the FPL model. However, the USGS model had a coarser discretization than the FPL model. Although the scale and discretization of the USGS model was not appropriate for providing accurate estimates of water volumes captured by the RCWs from different sources, it did provide information about potential RCW effects on salinity in the Biscayne aquifer and Biscayne Bay. For the continuous pumping scenario, the operation of the RCWs decreased aquifer salinity in an area centered northwest of Turkey Point. This was caused by the replacement of hypersaline water from the IWF with fresher water from the aquifer, adjacent canals, or Biscayne Bay. As described in Appendix G, the USGS model predicted increasing aquifer salinity in a ring around the IWF from continued migration of the IWF hypersaline plume. Predicted increases were near 40 psu in areas west of the IWF. The increase was predicted for scenarios both with and without RCW pumping and is not related to construction or operation of the proposed units.

If the RCWs are used as a backup supply of cooling water, the proportion of water flowing into the RCWs from the Biscayne aquifer is expected to be small, with over 95 percent of the water flowing into the RCWs coming from the overlying Biscayne Bay. This estimate is supported by separate groundwater modeling efforts performed by FPL and by the USGS, as described above. The modeling provided evidence that pumping of the RCWs as a backup water supply for 60 days per year or less would be unlikely to cause a significant increase in salinity within the bed of Biscayne Bay or within the bay itself compared to the variability that occurs under current conditions. The models also indicated that pumping the RCWs for 60 days per year or less is unlikely to cause a noticeable change in the existing extent of saltwater intrusion or to noticeably lower groundwater levels to such an extent that it would affect other users of the Biscayne aquifer. The review team recognizes that complete knowledge of the hydrologic system associated with the RCWs is not now available, and that uncertainties therefore remain in the impact analysis. Further, future operational and environmental conditions are not known with certainty. A vast number of future scenarios are plausible. The sources of uncertainty in the RCW analysis include: heterogeneity in subsurface parameters, lack of experience with RCW systems in carbonate strata, and uncertainty in the potential need for using the backup water supply. Uncertainties in the future site environment include: freshening of IWF cooling canals, remediation of the subsurface hypersaline plume, and the magnitude and rate of future sea level rise. In view of these uncertainties, the review team has taken care to avoid relying too heavily on numerical models, and has concludes that even the general conservatism adopted in the analysis does not ensure that the analysis is bounding of all future conditions. Accordingly, the review team does not rely solely on the output of any numerical model.

Numerical models are numerical representations of complex processes occurring in three dimensions over time. The appropriate role of a numerical model is to test assumptions of the behavior of complex systems. While running a numerical model numerous times with different parameters cannot compensate for all uncertainties, the models employed here have been tested and benchmarked within the conditions that limit their application. In this assessment the review team used models to test possible consequences of changes in the affected environment and uncertainty in some subsurface parameters within the capability of the models employed. This information was combined with the geography of the RCW field (such as the relatively short distance from the laterals to the bottom of Biscayne Bay relative to the distance from the laterals to the Homestead well fields) and the COC requirement of a monitoring program with mitigation options. The review team determined that the proposed monitoring of RCW construction and operation that is included is sufficient to detect unexpected behavior in a timely manner. While all possible mitigation measures have not yet been spelled out, in accordance with the COCs, the review team considers the ultimate mitigation of ceasing operation of the RCWs as ensuring prevention of any impacts in a timely manner. “When harm occurs, or is imminent, SFWMD will require Licensee to modify withdrawal rates or mitigate the harm” (FDEP COCs Page 61).

All groundwater models are subject to uncertainty caused by model assumptions and limited characterization data. Therefore, results from both the USGS model and the FPL groundwater model were only used qualitatively by the review team to understand potential impacts. The model results combined with the available characterization data supporting the leaky character of the Biscayne aquifer, and give confidence that the fraction of fresh groundwater that would be captured by the RCWs is small compared to the fraction that would come from saltwater in the bay. The review team estimated that the worst-case volume of groundwater removed from the Biscayne aquifer could reasonably be as high as 4,500 gpm during RCW operation. This represents 5 percent of the water produced by the RCWs and is conservatively 166 times greater than the fraction estimated by the base-case FPL groundwater model.

The review team determined that the proposed monitoring of RCW construction and operation is sufficient to detect unexpected behavior in a timely manner. While all possible mitigations are not detailed in the Conditions of Certification, the review team considers the ultimate mitigation of ceasing operation of the RCWs as ensuring prevention of any impacts in a timely manner. “When harm occurs, or is imminent, SFWMD will require [the] Licensee to modify withdrawal rates or mitigate the harm” (FDEP COCs Page 61). If reclaimed water is not available and the 60-day limitation on RCW pumping is exhausted, the plant can be safely shut down. Cooling the main condenser is not a safety function in the AP1000 design. Accordingly, there is no NRC requirement for a contingency plan to supply for emergency backup cooling water to the main condenser if reclaimed water is not available and the 60-day limitation on RCW pumping is exhausted. The plant can be safely shut down if water is not available from either source. Safety-related cooling water is stored onsite, and can be replenished from multiple sources. In a situation where the RCWs water may be needed, the EIS analyzes the case in which the RCWs would not operate more than 60 days per year as a bounding case. The case of continuous pumping was also analyzed as a sensitivity case. The primary source of cooling water, reclaimed wastewater from the Miami-Dade Water and Sewer Department, should be highly reliable, and therefore the availability of backup cooling water supplies need not be evaluated. Further, the review team also considered alternative sources of cooling water in EIS Section 9.4.2, none of which are environmentally preferable to the proposed sources of cooling water. In view of the high reliability of the reclaimed wastewater source and the availability of the RCW system as a backup, there is no need to consider additional backup sources of cooling water. Saline water from the RCWs beneath Biscayne Bay would only be used when reclaimed treated wastewater is not available in sufficient quantity or quality, and for a maximum of 60 days per year, as permitted under the Florida State Conditions of Certification. These limited periods of pumping of the RCWs will reduce the hydraulic head in the aquifer beneath Biscayne Bay near the wells and, therefore, will remove some water from the aquifer. However, the proportion of water flowing into the RCWs from the aquifer is expected to be small and over 95 percent of the water flowing into the RCWs is expected to be from the overlying Biscayne Bay. This estimate is supported by separate groundwater modeling efforts performed by FPL and by the USGS (Appendix G).

The models indicated that pumping the RCWs for 60 days per year or fewer is unlikely to cause a noticeable change in the existing extent of saltwater intrusion or to noticeably lower groundwater levels to such an extent that it would affect other users of the Biscayne aquifer. A vast number of future scenarios are plausible. The sources of uncertainty in the RCW analysis include heterogeneity in subsurface parameters, lack of experience with RCW systems in carbonate strata, and uncertainty in the potential need for using the backup water supply. Uncertainties in the future site environment include freshening of the IWF cooling canals, remediation of the subsurface hypersaline plume, and the magnitude and rate of future sea-level rise. In view of these uncertainties, the review team has taken care to avoid relying too heavily on numerical models, and concludes that even the general conservatism adopted in the analysis does not ensure that the analysis is bounding of all future conditions. Accordingly, the review team does not rely solely on the output of any numerical model.

Changes in the IWF Hypersaline Plume

If it becomes necessary to use the backup water supply, RCW pumping of saline groundwater from Biscayne aquifer beneath Biscayne Bay, could also affect movement of the hypersaline groundwater plume from the IWF cooling canals (described in Section 2.3.1.2). Under current conditions, most of the hypersaline water leaking from the cooling canals into the underlying groundwater system flows eastward beneath Biscayne Bay and likely mixes with bay water. The movement of this water in the subsurface is affected by tidal fluctuations that reverse the flow direction and by the complex mixing pattern of the ground waters with differing densities (Hughes et al. 2010-TN1545). Some hypersaline groundwater may move westward, although the interceptor ditch located on the west side of the IWF is operated to prevent inland movement of hypersaline groundwater (FPL 2014-TN4058). Pumping from the RCWs would increase the hydraulic gradient to the northwest. Both the FPL and USGS groundwater models (Appendix G) predict that some hypersaline water from the cooling canals would be drawn into the RCWs during extended periods of pumping. The increased gradient during RCW pumping would likely increase the flow velocity of hypersaline water eastward under Biscayne Bay and may change the area affected by the hypersaline plume.

After publication of the draft EIS, the review team performed additional groundwater modeling of the interaction between the planned RCWs, the existing hypersaline plume, and the cooling canals using a 2D cross-section model and a limited-extent 3D model. A more detailed description of this review team focused analysis is provided in Appendix G and in Oostrom and Vail (2016-TN4739). These models accounted for fluid density effects caused by salinity and temperature. The simulations were performed to better understand how the existing hypersaline plume may be affected by RCW pumping combined with remediation actions stipulated in a recent Consent Agreement between FPL and Miami-Dade County (Miami Dade County v. Florida Power & Light 2015-TN4505).

The modeling was useful in showing salinity changes that occur in the aquifer near the RCWs when the wells are operated. The results showed that when the wells are not operating hypersaline water from the cooling canals is present in the high-permeability zone where the well laterals are installed. This saline water would be drawn into the wells during the first few days of RCW pumping, resulting in increasing, then decreasing, salinity at the well. The salinity of the water produced by the operating RCW eventually would drop to about the concentration of the bay water. Water flowing down through the bed of the bay and into the RCWs would be expected to have about the same salinity as bay water. When RCW pumping ceases, water in the high-permeability zone would again increase in salinity because of the migration of water from the hypersaline plume into the high-permeability zone. This migration of hypersaline water into the high-permeability zone would occur regardless of the presence of the RCWs.

Predicted future change in sea level and its effect on interactions between the RCWs and the hypersaline plume were also simulated. The additional modeling confirmed that pumping of the RCWs would move hypersaline water toward the RCWs and would remove some groundwater captured by the RCWs from the hypersaline plume region of the Biscayne aquifer. The model also indicated that RCW pumping is not likely to reduce the effectiveness of hypersaline plume remediation actions specified in the Consent Agreement.

Changes in Groundwater Chemistry Caused by Movement of Bay Water into the Aquifer

Operation of the radial wells will induce water from Biscayne Bay to enter the material bottom at the top of the bay floor in the vicinity of the RCWs. The natural variability of the substrate will result in some preferential flow paths. The water chemistry along these flow paths may be altered as the well-oxygenated water from the Bay displaces the existing pore water. The substrate water quality is unknown and the nature of preferential flow paths is also currently unknown. However, previously in this section the review team has estimated the extent of the area possibly influenced by the RCW operation. Any increase in the density of preferential flow paths would reduce the area of influence and thereby reduce the extent of the changes in substrate water quality.

Changes in Hydraulic Heads and Saltwater Intrusion from Increased Demand on the MDWASD Potable-Water Supply

As described in Chapter 3 of this EIS, potable and service water for operation of the proposed units would be obtained from the MDWASD potable water-supply pipeline. Potable water from the MDWASD is almost entirely from the Biscayne aquifer in Miami-Dade County. Average increased demand for MDWASD potable water was estimated to be 1.5 Mgd based on normal use of 936 gpm with an occasional maximum use of 2,553 gpm for operating the proposed units (FPL 2014-TN4069). This represents less than 0.5 percent of the 349.5 Mgd that MDWASD is permitted to pump each year from the Biscayne aquifer (SFWMD 2012-TN1318). Any additional groundwater withdrawals required to meet Miami-Dade County needs will be managed under SFWMD policies to minimize impacts on the Biscayne aquifer. Therefore, the review team determined that the impact of this increased demand for potable water from MDWASD on Biscayne aquifer water levels and saltwater intrusion along the coast will be negligible.

5.2.1.3 Boulder Zone

Hydrologic alterations affecting the Boulder Zone of the Lower Floridan aquifer would result from the injection of up to 90 Mgd of blowdown water and other liquid waste streams from the proposed units. The injected water would include effluent from the sanitary waste-treatment plant, wastewater-retention basin, and liquid radwaste treatment system. The estimated injection rate is approximately 20 Mgd when only reclaimed water is used as a cooling-water source, as high as 90 Mgd when only saltwater from the RCWs is used, and between 20 Mgd and 90 Mgd if a combination of these water sources is used (FPL 2014-TN4058). However, the review team has determined that since reclaimed water will be the primary source injection rates higher than 20 Mgd will occur only on rare occasions and for short durations.

Composition of Injected Wastewater

Chemical constituents and concentrations in the injected water would vary depending on whether the source of cooling water is reclaimed water or saltwater from the RCWs. Chapter 3 provides details about the plant processes that affect the blowdown water composition and properties. Chemical constituents and concentrations expected to be present in water injected in the Boulder Zone are listed in Table 3-5 (Section 3.4.4.2) for both 100 percent reclaimed water as a cooling-water source and for 100 percent saltwater from the RCWs. FPL estimated these concentrations (FPL 2012-TN263) by adjusting the expected influent concentrations (reclaimed water or saltwater) based on the chemical changes expected to be caused by the RWTF, the circulating- and service-water systems, concentration in the cooling towers, and dilution to reduce radionuclide concentrations prior to discharge into the UIC wells. The concentrations for the reclaimed water case were estimated from analysis of composite effluent samples collected at the Miami-Dade SDWWTP from 2007 to 2011 and reported to the FDEP's UIC program. Concentrations for the saltwater case were based on analysis of samples collected from the production well during a pumping test conducted on Turkey Point from April 4 through May 5, 2009, from a monitoring well (MW-1 D2) on the Turkey Point site, and from a surface-water sampling location in Biscayne Bay (SP-1).

Upward migration of wastewater into an USDW, which has occurred at several Class I municipal disposal wells in Florida, was historically prohibited by Federal and State Underground Injection Control (UIC) regulations and the Safe Drinking Water Act (SDWA). Previously, facilities where migration into USDWs had occurred would have been forced to cease injecting and adopt an alternate wastewater disposal method. However, due to the severe local restrictions on wastewater disposal alternatives in Florida, the EPA revised the Federal UIC requirements for Florida to allow continued disposal well operations where migration had occurred, provided the injected wastewater is given "pretreatment, secondary treatment, and high-level disinfection prior to injection" in order to "provide an equivalent level of protection to USDWs as provided by the existing no-fluid-migration requirement of the Safe Drinking Water Act" (EPA 2005-TN4766). EPA considered this alternative to be "as effective as confinement of fluids in protecting USDWs from contaminants in wastewater" (EPA 2005-TN4766) and stated that after additional treatment, "the movement of fluids into the USDWs, whether known or suspected, should not endanger the USDWs because the quality of the wastewater has been treated to a level that is no longer a threat to USDWs" (EPA 2012-TN4782). EPA indicated that it understood that FDEP, which oversees the UIC program in Florida would propose state regulations that were equally or more stringent.

On April 29, 2004, FDEP and MDWASD entered into a Consent Order to address issues including fluid movement at the SDWWTP (Miami-Dade County 2014-TN4758). In accordance with the 2004 Consent Order, MDWASD was to treat wastewater at the SDWWTP to a higher than secondary treatment, including additional filtration and high-level disinfection (HLD) before disposal via injection wells. The impacts of migration of injected wastewater receiving advanced treatment from the SDWWTP was evaluated prior to implementation of this system using numerical modeling conducted by the USGS (Dausman et al. 2008-TN4757) and is discussed below. The HLD Facility at SDWWTP was completed in FY2013 (Miami-Dade County 2014-TN4758) and reclaimed water received by FPL from the SDWWTP and injected into the Boulder Zone will receive both filtration and high level disinfection as part of this advanced treatment. Additional sampling performed at the SDWWTP from 2013 to 2014 to determine seasonal variability of the concentrations of heptachlor, ethylbenzene, tetrachloroethylene and toluene, which are constituents in treated wastewater, also provide insight into the effect of this treatment on constituent concentrations. Concentrations for these constituents determined through this more recent sampling were below both EPA maximum contaminant levels and laboratory method detection limits, as indicated in the footnotes to Table 3-5 (NRC 2015-TN4773). These were lower than the values reported in Table 3-5 and may better represent the concentrations expected in reclaimed water that will be received by Turkey Point. The concentrations do not reflect the additional reduction which would occur due to treatment, volatilization, and dilution at the Turkey Point site before injection. In view of the above, the treatment that the reclaimed wastewater will receive at the SDWWTP will provide protection to the USDW even in the event of upwelling. Confinement of the wastewater below the USDW, which is discussed below, will provide an additional level of protection.

Evaluation of Confinement of Injected Wastewater in the Saline Lower Floridan Aquifer

The purpose of the evaluation of deep well injection presented in the FEIS is to determine the impacts to water resources that might reasonably occur if Units 6 and 7 are licensed. The responsibility to demonstrate that plant effluent injected in to the Boulder Zone will not impact overlying USDWs is that of FPL and is required as part of the FDEP UIC permit. To evaluate the impacts of deep well injection at the Turkey Point site, the review team 1) reviewed studies that characterized the confining ability of the MCU and the causes and extent of upwelling at other deep well injection sites, 2) compared hydrogeological conditions and parameters at the sites at which upwelling occurred to conditions and parameters at the proposed site, 3) evaluated numerical modeling of flow of injected wastewater presented by the applicant and performed confirmatory calculations, and 4) considered the injection well testing and groundwater monitoring requirements of the FDEP UIC program. As a result of this evaluation, the review team concluded that significant upwelling of injected wastewater is not likely at the Turkey Point site and that, if upwelling did occur it would not noticeably impact overlying USDW aquifers.

As described in Section 2.3.1.2, the Boulder Zone contains saline water and is regionally isolated from the overlying Upper Floridan aquifer by a thick section of low-permeability sediments of the middle confining unit (MCU). Information from an exploratory well constructed at the Turkey Point site identified highly porous and permeable rocks that form the upper portion of the Boulder Zone at a depth of 3,020 to 3,232 ft below the drill pad.

Almost all of the injected wastewater is expected to be from periods when Units 6 and 7 are using reclaimed water as a cooling-water source. Because the injected wastewater would have a lower TDS content and an elevated temperature compared to the native water in the Boulder Zone, the injected wastewater would have a lower density than that native water, resulting in buoyancy. Wastewater from periods when the plants are using water from the RCWs is expected to have a higher density than the native Boulder Zone water, resulting in negative buoyancy. These periods are expected to be rare and of short duration.

As described in Section 2.3.1.2 of this EIS, the naturally-occurring hydraulic gradient in the Boulder Zone is small and water flows slowly to the west. The natural gradient is very small compared to the pressure developed at the injection point into the Boulder Zone by the injection pumps, as discussed below. Accordingly, the injected reclaimed wastewater will be forced in all directions from the injection point into the Boulder Zone. In addition, when reclaimed wastewater is used, buoyant forces will dominate the small natural gradient due to the lower density warm injectate, resulting in an overall upward hydraulic gradient in the Boulder Zone. Upward flow of injected wastewater would nonetheless be inhibited by the more than 1,465 ft thick sequence of predominately low-permeability rocks that lie between the Boulder Zone and the USDW aquifer (FPL 2012-TN1577).

FPL performed an analysis of the pressure buildup by the injected wastewater (FPL 2014-TN3932). FPL calculated a maximum total pressure increase of 158 psi in the injection formation from the combined injection pressure of 12 injection wells plus buoyancy of the injectate based on a reclaimed water source. This is much lower than the calculated 1,235 psi minimum pressure that could create or open a fracture in the overlying confining zone (FPL 2013-TN3931).

Based on the above evaluation, the review team concluded that in general the matrix of the MCU would confine injected effluent and that incidences of upwelling at other sites have been coincident with features that provide vertical pathways for upward migration such as fractures or improperly completed wells. Site data indicates that substantial fracturing of the confining layers is not evident at the Turkey Point site and well construction related issues are not expected to create potential for upwelling at the Turkey Point site because of improved understanding of the confining zones within the MCU and improved construction techniques. However, studies of other injection sites indicate that if rapid vertical migration occurs, it is not likely to reach the Upper Floridan aquifer and that, if it did, it would not noticeably impact drinking water quality. This is discussed in greater detail in Sections 2.3.1.2 and 5.2.3.2 and within the following portions of this section.

Extent of Upwelling at Deep Well Injection Facilities

Maliva et al. (2007-TN1483) reports that of the more than 180 Class I UIC wells, "in the majority of injection well systems, no vertical movement of injected fluids has been detected in the monitoring zones." Seventeen sites have experienced migration, however upwelling into the USDW had occurred at 8 of those sites. Three of these sites are in southeast Florida and include the SDWWTP, which is north of the Turkey Point site. Previous reports indicated that injectate had migrated into the Upper Floridan aquifer (Starr et al. 2001-TN1251; 68 FR 23673 [TN3658]; EPA 2003-TN4759). However, more recent studies, such as Maliva et al (2007-TN1483) and Walsh and Price (2010-TN3656) have clarified that while migration has reached the USDW at some Class I injection facilities, no impact has been reported for the Upper Floridan aquifer in southeast Florida including at the SDWWTP. As discussed in Section 2.3.1.2, this is likely because the earlier studies referenced above considered the APPZ, where upwelling was detected, to be the lower part of the Upper Floridan aquifer. As a result of more recent characterization of the Floridan aquifer in south Florida (such as Reese and Richardson 2008-TN3436), it is now understood that the APPZ is separated from the Upper Floridan aquifer in south Florida by the upper confining unit of the MCU. Results from characterization at EW-1 indicate that the upper confining unit of the MCU may separate the APPZ from the Upper Floridan by approximately 250 ft.

Also, the base of the USDW is defined by the depth at which TDS exceeds 10,000 mg/L. The depth at which groundwater TDS exceeds 10,000 mg/L may occur beneath the base of the Upper Floridan Aquifer as it does at the SDWWTP. Therefore, upwelling into the USDW does not necessarily indicate that upwelling has reached the Upper Floridan aquifer. However, review of data from well EW-1 indicate that the base of the USDW and Upper Floridan aquifer occur around the same depth at the Turkey Point site.

Potential Causes of Upwelling of Injected Wastewater through the Middle Confining Unit

Many studies have been conducted to characterize the confining nature of the MCU and determine the causes of upwelling, where it has been observed. Studies have evaluated whether observed migration was caused by flow through the matrix of the MCU or through pathways provided by either natural geologic features or well-related problems. These studies generally conclude that the MCU matrix provides adequate confinement, that rapid flow results may result primarily from well-related issues, and that significant upwelling has not occurred at injection sites. These studies are summarized in the following paragraphs.

Starr et al. (2001-TN1251) reviewed "existing information that describes geology, hydrogeology, and geochemistry at the South District Wastewater Treatment Plant" to determine "the ability of the confining layer above the saline aquifer to prevent fluid migration into the overlying freshwater aquifer." The aquifers referred to are the Boulder Zone (the "saline aquifer") and the Upper Floridan aquifer (the "freshwater aquifer"). However, the Upper Floridan aquifer is brackish, not fresh, in the vicinity of the site. The Starr study expressed concern over the adequacy of the data set being evaluated and concluded that "the geologic data provided for review are not sufficient to demonstrate that the Middle Confining Unit is a competent, low hydraulic conductivity layer that is capable of preventing upward migrations of fluids from the

Boulder Zone into the overlying underground source of drinking water" or USDW. According to the report:

- "Although the confining layer above the Boulder Zone may in fact be competent, these data sets are not adequate to draw this conclusion."
- "A caveat to this interpretation is that the hydraulic characterization test methods employed may not adequately represent the less permeable hydrostratigraphic units, and hence the hydraulic data set may not adequately describe the actual site conditions."
- "…the geochemical data do not show a spatial pattern of contamination that is consistent with widespread upward migration of contaminated water through a highly permeable confining layer."

Rather than indicating a lack of confinement by the MCU, the study concludes that "the Middle Confining Unit and/or upper portion of the Lower Floridan Aquifer is a better confining unit than indicated" by the data that was provided for review. The study concluded that overall the spatial distribution of contaminants "suggests that isolated conduits, such as inadequately sealed wells or natural features, provide pathways for contaminated water to migrate upward from the Boulder Zone, but contaminants are not migrating upward through the Middle Confining Unit across a broad area."

This lack of observed migration across a broad area was also investigated by Maliva et. al. (2007-TN1483). Maliva, et al., studied vertical hydraulic conductivity data from core plugs from the MCU at 29 South Florida injection well sites (including the SDWWTP) and performed variable density solute-transport modeling. They observed that "matrix hydraulic conductivities of the limestone and dolostones that constitute the confining strata between the injection zone and the base of the USDW in South Florida are sufficiently low to retard significant vertical fluid movement" and that minimal vertical migration would occur through sections where vertical hydraulic conductivity was 10^{-6} cm/sec or less. As discussed in Section 2.3.1.2, intervals of dolomitic limestone and dolomite with hydraulic conductivities measured as low as 10^{-6} cm/sec occur within the MCU at well EW-1 at the Turkey Point site. As a result, these intervals at the Turkey Point site would be expected to prevent or limit vertical migration.

McNeill (2002-TN4571) recognized a thin "important low-permeability interval" which "appears to act as a competent confining unit" between the Boulder Zone and Middle Confining Unit throughout southeastern Florida. He referred to this interval as the Dolomite Confining Unit and identified characteristics of the unit that were indicative of confinement. These included zones in which the data showed high core recovery and low hydraulic conductivity, and other confining characteristics as indicated by geophysical logs. The review team observed zones with similar confining characteristics at several depths within the MCU at well EW-1 at the Turkey Point site.

Several studies indicated that upwelling may result from natural features or well-related issues. Dausman et al. (2010-TN4760) agreed that MCU "heterogeneity cannot explain all the effluent migration" and indicated that upwelling at the SDWWTP can generally be attributed to "…flow through a channelized pathway caused by well construction." At the SDWWTP, McNeill (2002-TN4571) indicated that upwelling likely occurred because 10 of 17 injection wells were drilled through but completed above the Dolomite Confining Unit at the base of the MCU, effectively leaving an open hole and upward pathway through which injected effluent could migrate.

Lastly, Walsh and Price (2010-TN3656) evaluated well logs and water chemistry data at the SDWWTP and determined that while natural features could not be ruled out, enhanced vertical flow pathways that allowed upwelling likely resulted from issues related to well installation or failure because effluent appeared to bypass deeper monitored intervals before being detected at higher depths.

Even if the MCU matrix is generally confining and wells are installed properly, upwelling may still result from fracturing or other natural geologic features within the confining zone. Cunningham (2012-TN4576; Cunningham 2013-TN4573; Cunningham 2014-TN4051; Cunningham 2015-TN4574) evaluated injection sites for natural vertical high conductivity features (such as karst collapse structures) using seismic-reflection data. He stated that “if present at or near wastewater injection utilities, these features represent a plausible physical system for the upward migration of effluent injected into the Boulder Zone to overlying EPA-designated USDW in the upper part of the Floridan aquifer system.” In the most recent study, karst collapse features have been identified in the vicinity of the North and South District Wastewater Treatment Plants as well as locations beneath Biscayne Bay and have been found to extend from the MCU to above the Upper Floridan aquifer (Cunningham 2015-TN4574). These structures are beyond the zone of influence of the injection wells proposed at the Turkey Point site, as described below. At an injection well operated by the City of Sunrise in Broward County a collapse structure was implicated in the observed migration of injected wastewater from the Boulder Zone to the uppermost permeable zone within the Lower Floridan aquifer however migration of contaminants above the Lower Floridan aquifer was not observed at this site (Cunningham 2014-TN4051). Migration above the APPZ and into the Upper Floridan aquifer resulting from natural features has not been identified at any site in south Florida.

Deep seismic data has not been collected at the Turkey Point site. In the absence of seismic data, Cunningham (2015- TN4574) suggests that, “other evidence for karst collapse includes borehole log signatures that indicate highly fractured rock,” and that fractures would be indicated by “..high travel times measured on borehole sonic log data.” Walsh and Price (2010-TN3656) reported that at the SDWWTP “no fracturing of the confining strata had been reported.” Using geophysical (sonic) logs from injection sites in south Florida, Maliva et al (2007-TN1483) and McNeill (2002-TN4571) described signatures and travel times for fractured rock. Staff evaluated travel times and signatures on sonic logs obtained at well EW-1 at the Turkey Point site and found sections of the MCU to have log signatures and transit times consistent with unfractured rock. Dissolution rates for limestone and dolostone presented by Palmer (2016-TN4755) are low, indicating that if fractures in the MCU at the Turkey Point site are absent or poorly developed, such fractures are not likely to become conduits capable of upwelling over the life of the plant. In order for rapid flow of injected effluent to occur from the Boulder Zone through the MCU as a result of these natural features, they would have to occur within the zone of influence of an injection site and create a set of pathways that compromise the approximately1500 ft thick MCU. However, characterization data indicates that these features are not evident at the site and modeling suggests that the expected zone of influence of injected wastewater is not expected to extend far beyond the boundaries of the Turkey Point site, as described below.

The review team evaluated the potential for upwelling due to flow through a competent MCU matrix or pathways created by natural features or well-related issues. Review of hydrogeological parameters at the site indicate that the MCU would be expected to offer confinement absent the presence of conduits. Results of borehole characterization activities at exploratory well EW-1 (FPL 2012-TN1577) and DZMW-1 (MHC 2014-TN4052) indicated that there were thick sections of low permeability sediments between the Boulder Zone and the Upper Floridan aquifer at the proposed Turkey Point injection site. Monitoring results from the water-injection testing at these wells above these low permeability strata did not indicate pressure fluctuations indicative of lack of confinement due to matrix flow or flow through pathways caused by either improper well construction or natural features (FPL 2014-TN4052). Installation, testing and monitoring required by the FDEP UIC permit are designed to prevent upwelling resulting from improper well construction and detect upwelling associate with the wells if it occurs. The review team notes that the one injection well has been drilled and characterization of the thickness and competency of the MCU is also required at each subsequent well location by the UIC permit process. The UIC permit for each well may not be issued unless adequate confinement has been demonstrated by the well-specific characterization data. The review team believes that enhanced vertical flow through the confining units to the Upper Floridan aquifer is extremely unlikely, and if leakage associated with an injection well did occur it could be detected and mitigated as required by the FDEP UIC program.

Extent of Injected Wastewater Migration at the Turkey Point Site

In order to understand the fate of injected wastewater at the Turkey Point site the review team evaluated local and regional site studies and modeling of the SDWWTP site, modeling conducted at the Turkey Point site by FPL, and independent confirmatory modeling by the review team.

Dausman et al. (2008-TN4757) modeled migration of two plumes from the SDWWTP of wastewater injected into the Boulder zone: one comprised of secondarily treated wastewater and another of wastewater receiving HLD, which has since been implemented along with additional filtration at the SDWWTP site. The Dausman study concluded that over a projected 148-year injection period (from 1983 forward) the resulting plume would extend "…outward about 13 mi from the site in the MFA, just beneath the UFA." The MFA, or Middle Floridan aquifer, is another name for the APPZ. Modeling also indicates that the initial concentration of constituents in the plumes would be significantly reduced through dilution, to less than 5 percent of the original injected concentration by the end of the modeling timeframe.

This prediction of limited vertical and horizontal effluent migration is supported by modeling and analysis performed by FPL and independent confirmatory analysis performed by the review team. FPL provided information about modeling and analysis of several scenarios of potential upward migration of injectate (FPL 2013-TN3931) in support of the safety analysis of the proposed plants. The scenarios in the analysis focused on the fate and transport of radionuclides over a 61-year injection period followed by a 41-year period with no injection, and used conservative assumptions that would tend to maximize the upward migration of effluent. In each scenario, injected wastewater was predicted to expand radially around the point of injection since injection rates would exert a stronger influence on flow than the negligible flow rates naturally occurring within the Boulder Zone. Injected wastewater was not predicted to extend more than around 4 mi beyond the point of injection over the modeled timeframe. This is bounded by the transport distance of 13 mi predicted by Dausman et al. (2008-TN4757). The extent of migration resulting from injection at Turkey Point would be expected to be less because injection rates would be around 20 percent of those at the SDWWTP and the injection period would be less than half that which was modeled by Dausman et al. (60 years vs 148 years).

One scenario evaluated by FPL determined that, in the absence of well-developed pathways, upward movement of injectate would be limited to approximately 300 ft into the MCU. The primary confinement portion of the MCU above the injection zone is 985 ft thick (FPL 2012-TN1577) and is overlain by an additional 480 ft thickness of moderate- to low-permeability layers of rock below the Upper Floridan aquifer. The staff performed a separate confirmatory analysis (Appendix G) and found that upward migration of injectate from the Boulder Zone would likely be less than 300 ft. These estimates of limited upward migration are supported by the conclusions from the studies of matrix flow through the MCU discussed earlier in this section.

FPL's safety analysis also considered a scenario in which a pathway through the MCU exists. In this scenario, a hypothetical water-supply well located 2.2 mi from the reclaimed wastewater injection site was drilled into the USDW aquifer and an instantaneous bypass/failure of the MCU occurred at the water supply well. The 2.2 mi distance is based on the nearest privately owned parcel of land. The FPL analysis showed that the transit time through the Boulder Zone from the injection well to beneath the offsite location would be at least 10 years, and the maximum radionuclide concentrations for tritium would not occur until year 21 (FPL 2013-TN3931). This analysis was conservative in that it did not account for transit time through the MCU and did not account for dilution of effluent within the Boulder Zone or Upper Floridan aquifer. It assumed that 100 percent of the water pumped by the water-supply well would be from the Boulder Zone with no dilution in the Avon Park Permeable Zone (APPZ) or the Upper Floridan aquifer. The review team performed a separate confirmatory analysis of this scenario (Appendix G), which predicted concentrations of radionuclides at the hypothetical well that were similar to those calculated by FPL. The assumptions of vertical migration in this scenario were made to determine a bounding dose. The conditions and parameters in this scenario have not been observed at operating injection sites and are not reasonably foreseeable based on the hydrogeology at the Turkey Point site.

FPL also considered impacts at the nearest user of brackish Upper Floridan aquifer groundwater, which is the Ocean Reef Club located on Key Largo 7.7 mi from the injection site. This scenario conservatively assumed that water from the existing irrigation supply well is used for drinking and other domestic purposes and there is a failure of confinement between the Boulder Zone and the Upper Floridan aquifer at the location of the water-supply well. FPL's radiological safety analysis at the Ocean Reef Club showed that radionuclide levels in the Upper Floridan aquifer would remain at inconsequential levels throughout the 100-year analysis period. This is expected since the wastewater is not predicted to travel this far beyond the injection well. Estimates of potential doses resulting from each of these scenarios are discussed in Section 5.9 of this EIS. While this evaluation considered the transport of radionuclides, predictions related to flow direction and horizontal extent would also apply to non-radiological constituents in the injected water.

The review team evaluated the impacts of this and other scenarios (direct injection into the Upper Floridan aquifer, upward migration through the MCU and rapid migration through preferential pathways through the MCU) using results from published risk assessments and modeling studies as well as expected constituent concentration data from reclaimed water at the Turkey Point site. The results are set forth in Section 5.2.3.2.

Another controlling factor on the direction of flow of injected wastewater was determined to be the structure of the confining layers that overly the Boulder Zone. McNeill (2002-TN4571) evaluated the structure and extent of a unit he called the Dolomite Confining Unit, which occurs at the base of the MCU in southeast Florida. McNeill indicated that while there is local variability in the bottom depth of the Dolomite Confining Unit, the overall dip of the unit is to the southwest. This implies that as distance beyond the injection well increases, flow of buoyant injected effluent may be more influenced by the structure of the base of the confining unit rather than injection pressure. As a result, any migration within the Boulder Zone beyond the site would move northeast toward (but beneath) the bay and away from areas in which the upper aquifers are used. As mixing, cooling and dilution occur, buoyancy of the injectate will decrease, causing it to eventually be subjected to the slow westward movement of the native water within the Boulder Zone (Meyer 1989-TN2255).

Finally, as described in Section 2.3.1.2 of the EIS, treated municipal wastewater injected into the Boulder Zone has migrated into relatively permeable zones within the MCU at the SDWWTP north of Turkey Point site, but has not reached the Upper Floridan aquifer. Studies have indicated that this migration could have resulted from well construction issues. Walsh and Price (2010-TN3656) presented a conceptual model that postulates the vertical migration through the lower portion of the MCU, below the APPZ, is fluid-density driven. Walsh and Price also determined that if migration into the APPZ occurred, “the transport mechanism appeared to be a horizontal flow with mixing of ambient waters” which would likely diminish the buoyant forces and reduce the impact above the APPZ. This conceptual model of horizontal flow in the APPZ overcoming the vertical flow component that dominated flow within the more confining MCU strata was also illustrated in a numerical modeling scenario by Maliva et al (2007-TN1483). This indicates that even where migration through the bottom portion of the MCU has occurred, upwelling to the upper MCU and the overlying Upper Floridan aquifer is not likely. This could partially explain why recent studies have indicated that upwelling to the Upper Floridan aquifer has not occurred at injection sites.

Based on the foregoing, the review team has determined it is reasonable to conclude that injected wastewater is not expected to migrate far beyond the site in the Boulder Zone, that upwelling to the Upper Floridan aquifer is not likely at the site, and that if significant upwelling through the MCU did occur, horizontal flow and mixing within the APPZ would likely prevent upwelling above the MCU. While not quantified by the review team, modeling near the site indicates that natural dilution of injected wastewater could significantly reduce the concentrations of constituents in wastewater. There are no users of groundwater within the Boulder Zone near the site, there are no users of groundwater within the Upper Floridan aquifer overlying the predicted extent of wastewater migration, and wastewater is not expected to migrate upward into the Upper Floridan aquifer.

Lastly, relative risk assessments of wastewater disposal methods in southeast Florida indicate that "distance has a major impact on risk" with the already low risk decreasing dramatically as distance from the injection well increases (Bloetscher et al. 2005-TN4756). The study considered scenarios that included breach of the MCU and determined that risk to receptors up to 5 mi from the injection well was minimal, which is similar to the migration distance indicated by site and regional modeling, as discussed above. Risk assessments that consider deep well injection are discussed in greater detail in Section 5.2.3.2.

5.2.1.4 Industrial Wastewater Facility (Cooling Canals)

Hydrological alterations affecting the IWF cooling canals, that would be associated with the operation of the proposed Turkey Point Units 6 and 7, may occur due to (1) drift deposition of contaminants on in the IWF (2) stormwater discharge to the IWF, (3) runoff from spoils piles, and (4), withdrawal of water from the IWF due to radial well operation.

Drift Deposition

The review team has conducted analyses to estimate drift deposition of chemical contaminants on aquatic and terrestrial habitats; these estimated depositions would be used for determining aquatic and terrestrial ecological effects. The methods of estimating drift deposition are discussed in the Biscayne Bay section above, and the estimated deposition rates are provided in Table 5-1, which includes the IWF cooling canals. Table 5-1 provides deposition rates with the use of reclaimed water as cooling-tower makeup water. The table includes concentrations in wastewater (or Biscayne Bay), ratios of constituent concentration to TDS concentration, and calculated deposition rates for each constituent to areas around the cooling towers.

The potential concern for the cooling canals, while not a water body regulated for water quality, is related to the potential impact on Federally protected crocodiles, which nest on the cooling-canal berms at several locations of the IWF. Most of the IWF is also designated critical habitat for the crocodile.

As noted in the section about Biscayne Bay, with the use of either the reclaimed water or RCWs, the deposition rates of potentially associated chemical contaminants is extremely low. Only TDS, chloride, and sulfide have deposition rates greater than 10^{-6} g/m^2/mo, and the IWF has concentrations of those that are greater than marine waters.

Using water and mass balance methods, the review team also calculated the equilibrium concentrations of contaminants within the cooling canals from drift deposition. To compute the mass balance, the review team first calculated a water balance using the cooling-canal storage information from the *Cooling Canal System Modeling Report* (Golder 2008-TN1072) and the FPL 2012 *Uprate Report* (FPL 2012-TN3439). The water balance data from FPL (2012-TN3439) was averaged by month and repeated over a 9-year period to provide inflows and outflows to the cooling canals for use in the mass balance calculations. Loading to the IWF and the flow balance of the IWF is discussed in Section 4.2.1.4. Figure 5-1 shows the review teams computed cooling-canal volumes for this period.

For the next step, the review team calculated the mass balance of each constituent in Table 5-1 using the hydrologic fluxes of the IWF to account for dilution of contaminant concentrations from drift deposition. For a conservative estimate, no loss of contaminants was assumed in the cooling canal from degradation or volatilization. Figure 5-2 provides an example of contaminant concentrations calculated from the mass balance of 1,4-dichlorobenzene, which is an insect repellent. Concentrations increase from the initial value of 0 µg/L and reach a dynamic equilibrium within approximately 4 years. The only input of contaminant is from cooling-tower drift, and the primary loss is via the seasonal inflows and outflows of groundwater, which produces the variation in volume shown in Figure 5-1. The maximum computed increase in concentration was 0.00070 µg/L. The same calculation was made for other potential contaminants deposited in the cooling canal from drift; the maximum concentrations attained are listed in Table 5-2. Comparison of the contaminant concentrations with detection limits indicates that all of the concentrations from this mass balance calculation are below current detection limits. Other chemical constituents with concentrations that were not measured in the reclaimed water, but which could have concentrations similar to those measured by MDWASD, would be expected to result in concentrations in the IWF as found above.

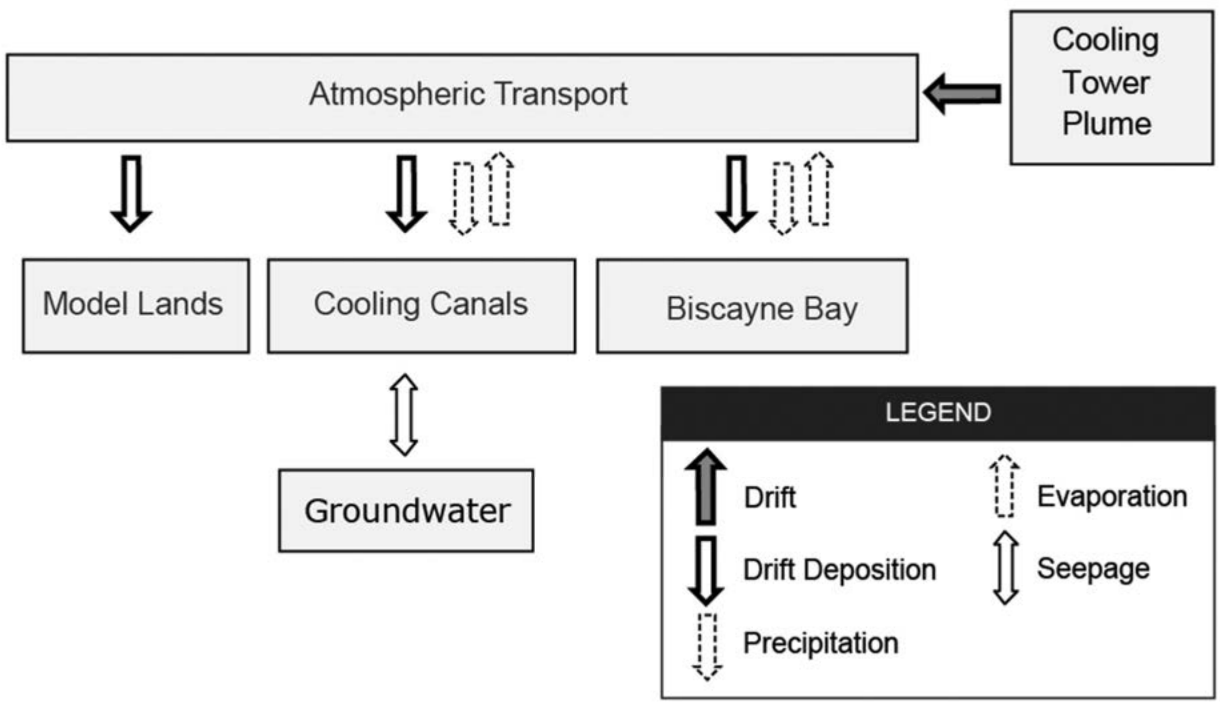


Figure 5-1. Schematic of Hydrologic and Mass Exchange Processes Considered in Estimating the Effects of Drift Deposition on the IWF Cooling Canals, Model Lands, and Biscayne Bay

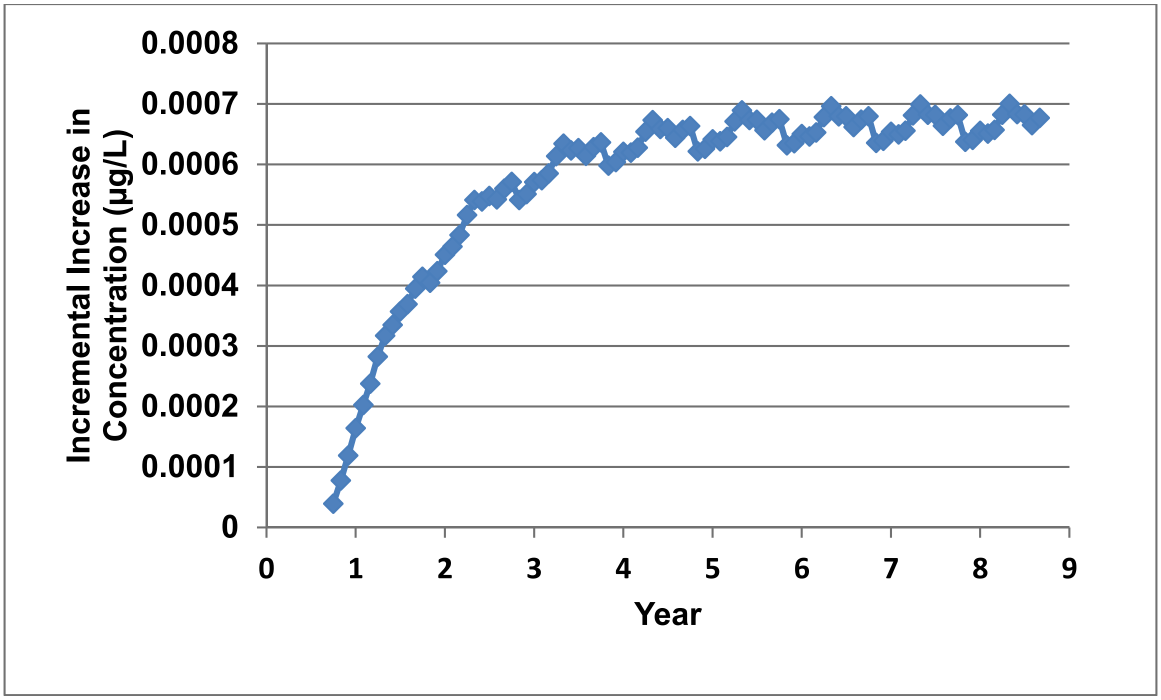


Figure 5-2. Concentrations of 1,4-Dichlorobenzene Based on Annual Average Drift Flux from the Cooling Towers over a 9-Year Period. ***Hydrologic conditions are those used to estimate the cooling-canal volumes shown in Table 5-2.***

Table 5-2. Estimated Contaminant Concentrations in the Cooling Canal from Drift Deposition. ***Detection or reporting limits are provided for comparison. Drift deposition is assumed to be the only source of contaminants.***

Contaminant	Method Detection Limit (µg/L)	Maximum Incremental Increases of Concentration in Cooling Canals (µg/L)	Category
		Reclaimed Water	
1,4-Dichlorobenzene	0.1[(a)]	0.00070	Insect repellant
3 Beta-coprostanol	0.52[(a)]	0.0011	Human digestion
4-Nonylphenol	0.64[(a)]	0.0022	Detergent metabolite
Acetyl-hexamethyl-tetrahydro-naphthalene (AHTN)	0.08[(a)]	0.0022	Polycyclic musk (e.g., tonalide)
Hexahydrohexamethylcyclo-pentabenzopyran (HHCB)	0.12[(a)]	0.00027	Polycyclic musk (e.g., galaxoide)
Phenanthrene	0.08[(a)]	0.00032	Polycyclic aromatic hydrocarbon (PAH) compound
Warfarin	0.012[(b)]	0.000064	Pharmaceutical
17 Beta-estradiol (E2)	2[(b)]	0.000019	Hormone
Triclosan	Unknown	0.060	Antimicrobial
Copper	6.0[(c)]	0.0052	Metal

(a) Lietz and Meyer 2006-TN1005.
(b) reporting limit
(c) FPL 2012-TN263.

G.3.1.3 Summary

The Biscayne aquifer transmissivity (T) and the vertical hydraulic conductivity (kv) of the confining zone above the Biscayne aquifer are important because they control the rates at which water will flow into the RCWs from the aquifer and the bay and impact the amount that is drawn from each potential source. The NRC staff's analyses resulted in K′/b′ values that vary from 0.23 to 0.53 d^{-1}, and average about 0.3 d^{-1}. If all the vertical resistance to flow is imposed by the muck layer, which averages in thickness (b') of 2 ft, then its vertical hydraulic conductivity is about 0.6 ft/d. This value is close to that determined by FPL (2009-TN1263).

The NRC staff found that values of T between about 800,000 and 1,000,000 ft^2/d are obtained from time-drawdown analysis of the APT using consistent r/B values, or from distance-drawdown analysis. Differences in the calculated T values arise because of uncertainty in steady-state drawdowns of only a few hundredths of a foot. Values from the staff's analysis are comparable with values determined by FPL (2009-TN1263), which states "The mean for the calculated T values using drawdown data is approximately 700,000 $feet^2$/day." Also, "The calculated T value using a distance-drawdown method is 800,000 ft^2/d." Thus, in spite of some inconsistency in analysis methods, results from the analysis prepared by FPL are similar to those determined in the NRC staff review.

G.3.2 Description of Groundwater Modeling Performed to Help Evaluate Effects of Excavation Dewatering and Radial Collector Well Operation on the Biscayne Aquifer

This appendix describes three separate modeling efforts performed to estimate the effects of radial collector well (RCW) pumping on the Biscayne aquifer, Biscayne Bay, and other portions of the hydrologic environment including nearby drainage canals and the cooling canals of the industrial wastewater facility (IWF). Two of these modeling efforts were performed before the NRC issued the draft environmental impact statement (EIS) in 2015, while the third was performed afterwards. The staff also used the two earlier studies to simulate the effects of dewatering the Units 6 and 7 plant excavations. To further confirm their understanding of the groundwater hydrodynamics and to consider whether certain actions proposed after the two earlier modeling studies were completed would alter the earlier conclusions documented in the draft EIS (EIS, NRC 2015-TN4444), the review team performed a third modeling analysis (Oostrom and Vail 2016-TN4739).

FPL conducted modeling (FPL 2014-TN4069) using a local-scale groundwater model of the Biscayne aquifer including the portion of the aquifer underlying Biscayne Bay near the Turkey Point site. The NRC commissioned the U.S. Geological Survey (USGS), to conduct additional modeling to help identify the potential effects of RCW pumping (NRC 2014-TN3078). As indicated above, after the Draft EIS was issued, the review team itself performed a third modeling analysis.

Each of these hydrologic models provides an estimation of the effects of building and operating the proposed plants, however these estimations are imperfect due to a number of uncertainties. Uncertainty in groundwater models has been described as arising from 1) uncertainty in model parameters, and 2) uncertainty in the definition of the conceptual model framework including the spatial and temporal variation in hydrologic variables (Neuman and Wierenga 2003-TN4090). Therefore, examining the results of the three modeling efforts provides a better understanding of the possible range of effects of building and operating Units 6 and 7.

The model used by the USGS model is a submodel of an existing regional-scale (Miami-Dade County) coupled surface-water/groundwater model originally created to evaluate then-recent hypersalinity events in Biscayne Bay, at the county scale, during 1996−2004 (NRC 2014-TN3078). The USGS model domain encompassed Biscayne Bay and included freshwater flows into Biscayne Bay through the offsite drainage canal system, exchange of groundwater between Biscayne aquifer and surface waterbodies including the Biscayne Bay, drainage canals, and the cooling canals of the IWF. It also included precipitation input to the bay, precipitation recharge to the Biscayne aquifer, evapotranspiration (ET) effects on bay salinity, and the effects of ET on recharge to the Biscayne aquifer. The USGS modified their existing model to include the cooling canals of the IWF, the proposed excavation dewatering wells, and four proposed RCW locations.

Both of the modeling efforts are approximations of the real physical system, and each has shortcomings that result in uncertainty in the modeling results. The FPL model assumes constant density fluid and does not represent the differences in density between fresh and saline water that can result in “density-driven” groundwater flow. The FPL model was strictly a groundwater model with surface-water features represented as boundary conditions. The FPL model area is much smaller than the USGS model and does not include as many offsite canals. However, the USGS model has much lower spatial resolution with 500 × 500 m cell size compared to FPL’s model which is variable and is refined to a 5 ft spacing in the area around the radial collector wells (FPL 2014-TN4069). Therefore, the USGS model’s representation of smaller-scale features is not as accurate as FPL’s model.

G.3.2.1 Summary of FPL Modeling

FPL performed groundwater modeling in support of its application for building and operating Units 6 and 7 at the Turkey Point site. The model was created using Visual MODFLOW, a commercial implementation of the USGS-developed MODFLOW 2000, and was a steady-state three-dimensional model that assumes constant density of the fluid being modeled. Measured heads applied in the model for non-seawater waterbodies (e.g., freshwater canals and hypersaline cooling canals) were corrected to equivalent seawater heads based on the fluid density ratio. The model and results are described in detail in Appendix CC of the FSAR (FPL 2014-TN4069). Therefore, only a brief summary and assessment are provided here.

The objectives of the model were to evaluate groundwater impacts of activities related to the building and operation of two new nuclear units by simulating groundwater flow in the Biscayne aquifer. The primary issues evaluated with the model were the following:

- expected rates of groundwater infiltration into excavations for the new reactor buildings
- origin of water pumped from the RCW, and
- sea water approach velocities to the bay floor during RCW pumping.

FPL calibrated the model by matching the groundwater level response to aquifer pumping tests performed at two wells (PW-7L and PW-7U) near the proposed plant locations and a well (PW-

1) near the proposed RCW on the Turkey Point peninsula. An additional aquifer test near the proposed plant locations (PW-6U) was simulated by the model as a "validation run."

FPL used the calibration process to estimate a variety of parameters which were included in their model. These included the horizontal hydraulic conductivity (Kh) and anisotropy (Kv/Kh; ratio of vertical (Kv) to horizontal (Kh) hydraulic conductivity) values for each of the 10 hydrogeologic units included in the model and the conductance values applied to head-dependent boundary conditions (cooling canals, regional canals, Biscayne Bay and model sides). The calibration parameters were varied manually until a model result was obtained that showed satisfactory agreement between simulated and observed pumping test drawdowns at monitored observation wells, as well as a reasonable match to understood directions and amounts of regional groundwater flow.

Model Results – Radial Collector Wells

Determining the environmental impacts of operating the proposed RCWs is the ultimate focus of the FPL groundwater model. The base case model results indicated that approximately 98 percent of water extracted from the RCWs originates in Biscayne Bay with most of the remainder coming from the cooling canals (industrial wastewater facility). Only 0.2 percent of the water produced was predicted by the base case model to come from the freshwater portion of the Biscayne aquifer. This is the water entering the model domain from head-dependent boundaries along the northwest corner of the model. With an assumed RCW continuous withdrawal of 120 Mgd, the predicted volume of water removed from the inland Biscayne aquifer was 0.36 Mgd or 250 gpm according to the base case FPL model. The worst-case sensitivity analysis conducted by FPL regarding extraction of water from the Biscayne aquifer was based on assuming values of vertical conductivity that were 50 percent of the values applied in the base case for all the model layers. This “worst-case” analysis predicted that 1.4 percent or 1,250 gpm would be continuously extracted from the Biscayne aquifer.

The model results indicated that the velocity of water moving downward from Biscayne Bay into the seabed is very low at less than 0.001 cm/s for all sensitivity cases.

The base case model predicted that 2.0 percent of the water extracted by the RCW would come from the industrial wastewater facility. A "worst" case of 3.2 percent of the extracted water coming from the industrial wastewater facility was predicted by cutting the vertical conductivity of all layers in half.

Assessment – Radial Collector Wells

The FPL model provides a reasonable, although uncertain, prediction of the impact of the RCWs on the Biscayne Bay and freshwater resources within the Biscayne aquifer. Parameter uncertainty in the FPL model prediction for the RCW water source is caused by several factors including the following:

- limited area of the pumping test observations used for calibration compared to the extent of the model
- large number of model parameters compared to the limited amount of calibration data

- limited data on the site-specific hydraulic properties of hydrogeologic units except at the pump test locations used in calibration
- lack of data on the hydraulic conductivity of the sediment at the bottom of Biscayne Bay.

Incomplete knowledge of the hydrogeologic system being modeled, the impacts of assuming constant density fluid, the assumption of a steady-state flow system, and problems related to discretization of the model into a cellular grid also cause conceptual model and structural uncertainty in the FPL model results.

One of the most significant uncertainties in the model is the hydraulic conductivity assigned to the sediment at the bottom of Biscayne Bay. The bay bottom was characterized as either "offshore sediment" or exposed "Miami limestone." Water entering the RCW from the bay must pass through one of these materials to enter the higher conductivity "upper high flow zone (UHFZ)" where the RCW are placed.

The NRC staff identified the following issues of potential concern with the FPL model setup:

- Specified heads for the "general head boundary conditions" at the northwest and southwest corners of the model were inconsistent. For the calibration simulations, the western boundary ends at the northwest corner with a specified head of 0.85 ft, while the northern boundary ends at that corner with a value of 0.65 ft. The western boundary ends at the southwest corner with a specified head of -0.2 ft, while the southern boundary ends at that corner with a value of -0.95 ft.
- The non-uniform lateral model discretization (row and column widths) exhibits moderately larger changes than the commonly accepted practice for finite-difference models. The accepted standard practice is for an increase in width between adjacent rows (or columns) to be 50 percent (width ratio of 1.5) or less, whereas the FPL model has increases of 100 percent.
- While the layer elevations mostly vary in a smooth fashion, there are places where adjacent cells of the same layer are offset vertically with no overlap, which differs from the accepted standard practice of 50 percent overlap. The lack of overlap is a result of the magnitude in elevation change over distance combined with the thinness of the layer.

However, the NRC staff expects that the impact of these issues is relatively minor in comparison to the uncertainty in the model parameter calibration.

FPL's base case model predicted that 2.0 percent of the water extracted by the RCW would come from the industrial wastewater facility. This prediction is also regarded as uncertain because of the parameter calibration uncertainty mentioned above and because of the potential effects of variable density fluid on the migration of the hypersaline plume. If the RCWs are operated continuously, then it is likely that the hypersaline water flow induced by the RCW from the industrial wastewater facility would be captured by the RCW. However, intermittent operation could result in an increase of hypersaline flow into the aquifer beneath the bay that could migrate into the bay when the RCW is not operating. The steady-state nature of the FPL model and the assumption of constant density fluids make the model inadequate for modeling this potential scenario.

The NRC staff performed limited runs of the FPL model to verify performance and check some additional sensitivity cases of interest. The main item of interest was the volume of water captured from the inland portion of the Biscayne aquifer along the northwestern corner of the model. A sensitivity case of 10X the base case offshore bay sediment hydraulic conductivity combined with 10X the base case Miami limestone sediment hydraulic conductivity and 10X lower general head boundary conductance was performed. The results showed that approximately 15 percent more water would be captured through the general head boundary along the northwestern corner of the model under these conditions.

Model Results – Inflow to the Power Block Excavations

The FPL model predicted that pumping rates of 96 gpm would be necessary for dewatering each of the excavations at Units 6 and 7. This is based on installation of essentially impermeable grout curtains at the sides of the excavations and grouting of the rock at the base of the excavation.

Assessment– Inflow to the Power Block Excavations

The model results for the dewatering calculations are also affected by model uncertainties discussed above. However, the NRC staff expects the impact of model uncertainty on these calculations to be less significant because of the smaller scale of the focus area. The permeability of the grouted base rock and side walls for the excavation are the primary parameters controlling inflow, and are easier to estimate than the large-scale hydrogeologic parameters that control the source of water captured by the RCW. Engineering controls are also feasible for mitigation of any adverse conditions that are encountered during the excavation activities.

Conclusions

The environmental impact of operating the proposed RCW system is the most important issue addressed by the groundwater model. The FPL model results indicate that continuous operation of the RCW results in extraction of a relatively small volume of water from the inland portion of the Biscayne aquifer and that the velocity of water moving downward from Biscayne Bay into the seabed is very low at less than 0.001 cm/s. The NRC staff's largest concern with the model is caused by uncertainty in the model parameters, especially in light of the limited area of calibration data and the large number of parameters that must be estimated. This may have a significant impact on the predicted volumes of water that would be extracted from the inland potion of Biscayne aquifer along the northwest corner of the model area and the amount captured from the industrial wastewater system. The NRC staff regards model estimates of inflow to the proposed excavations as more accurate than estimates of RCW captured water sources because of the knowledge of hydraulic parameters in that immediate area of the planned excavations.

G.3.2.2 Summary of USGS Modeling

The NRC commissioned the USGS to perform a numerical modeling study of the effects of the operation of a proposed RCW system at the Turkey Point site on surface and groundwater salinity. The resulting report (NRC 2014-TN3078) represents part of the review team's technical basis in its impact determination in this environmental impact statement (EIS).

Purpose of the Study

FPL proposes installing the RCWs at the Turkey Point site for use as a backup source of cooling water for proposed Units 6 and 7 in case of the loss of the normal water supply (reclaimed water from Miami-Dade County waste water treatment system). Neither the reclaimed water nor the water from the RCW system provides a safety-related function. The design of the RCW system and the flow from it are described in Chapter 3 of this EIS. Because of the potential during operation of the RCWs to alter the salinity of two sensitive and significant local water resources—the Biscayne Bay and the Biscayne aquifer—the review team commissioned the USGS independent modeling study. Salinity in Biscayne Bay is a concern because of the ongoing actions under the Comprehensive Everglades Restoration Plan (CERP) to restore freshwater flows to Biscayne Bay National Park (USACE/SFWMD 2011-TN1038). The Biscayne aquifer has been designated a sole-source aquifer by the U.S. Environmental Protection Agency and is critical to the region's freshwater supply.

Unique from other numerical modeling studies included in the review team's assessment, the USGS model explicitly considered density effects on the flow within and between the groundwater and the surface-water systems. The spatial and temporal patterns of salinity are primarily controlled by the flow of water. Therefore, an understanding of various processes resulting in flow is required for the review team to understand the plausible impacts of the RCW operation.

The commissioned study discussed herein relied on a numerical model developed and applied previously to this domain by USGS (NRC 2014-TN3078). This numerical model was used to simulate specific conditions that are understood to exist at the Turkey Point site and under boundary conditions consistent with the operation of the RCW system. The site conceptual model and the numerical model are discussed below.

Conceptual Model

The conceptual model of the region is consistent with a coastal freshwater-saltwater interface. Freshwater results from precipitation that infiltrates into the groundwater system and flows down gradient toward the ocean. As it approaches the seawater, the less dense freshwater tends to flow over the more dense seawater forming a saltwater wedge. The location of this saltwater wedge can move in response to increases and decreases in groundwater recharge from precipitation and also in response to groundwater pumping. Excess precipitation that does not enter the groundwater system through recharge can enter the ocean via sheet flow and channel flow. Several canals discharge freshwater during the wet season (summer to fall). However, along a portion of the area to the south of Turkey Point, the cooling canals prevent sheet flow from discharging to Card Sound and Biscayne Bay directly east of the cooling canals. The warm, hypersaline water in the unlined cooling canals also creates a plume of dense hypersaline groundwater under the cooling canals. Therefore, the site conceptual model reflects these conditions unique to the Turkey Point site. Further discussion of the hydrologic environment including the cooling canals can be found in Section 2.3 of this EIS.

The analysis considered the surface water (notably Biscayne Bay) to be vertically mixed (NRC 2014-TN3078). The review team considered this assumption and determined that because of the shallow depths of Biscayne Bay, particularly near Turkey Point, this assumption was not unreasonable for the examination of potential RCW impacts on salinity in Biscayne Bay. While localized areas of salinity stratification may develop, wind mixing is expected to keep Biscayne Bay well mixed. The analysis used two-dimensional circulation, which is driven in response to wind forcing and tidal elevation boundary conditions (NRC 2014-TN3078). The analysis also assumed that the tidal boundary had a typical seawater salinity of 35 practical salinity units (psu).

Given that one of the motivations for this study was to consider density-driven flow within the groundwater system, the conceptual model explicitly allows for multiple layers and for both vertical variations in hydrogeologic flow-related parameters and for salinity variations. The boundary conditions for the groundwater portion of the model are the freshwater piezometric heads at the boundary of the domain and the areal recharge rates over the extent of the land surface of the domain, which vary seasonally.

The conceptual model explicitly considers the surface-water/groundwater interface with exchange allowed in both directions depending on pressure gradients from upgradient freshwater inflows to groundwater, water-surface elevation differences along canals, well pumping, seepage of cooling canal waters to groundwater, and tidal head variation (NRC 2014-TN3078). For instance, marine waters of Biscayne Bay water can percolate into the bed, enter the groundwater system, and enter the RCWs, and freshwater can enter the Bay through groundwater discharge.

Evaporation of seawater results in increases of salinity. Poorly mixed shallow marine areas without sufficient freshwater inflow are likely to become hypersaline as a result of evaporation. The study included the effect of evaporation on salinity (NRC 2014-TN3078).

As described in Section 2.3 of this EIS, the groundwater underneath Biscayne Bay has salinity levels similar to the marine surface waters. Below the freshwater layer landward of Biscayne Bay, there is a wedge of saline water that intrudes inland. The freshwater underlying the land has a somewhat higher piezometric head than the groundwater underlying Biscayne Bay; hence, there is a flux of freshwater eastward toward Biscayne Bay. Seasonal rainfall patterns also influence the flux of freshwater with increased runoff and surface-water discharge to Biscayne Bay and increased infiltration into the surface layers of the groundwater. Additional components of the surface-water/groundwater system that exist at present include water-supply pumping around population centers, drainage ditches that intercept shallow groundwater, and the cooling canals at Turkey Point. Inland water-supply pumping withdraws freshwater from the groundwater, thereby reducing the piezometric head that drives the salinity wedge seaward. Drainage ditches intercept shallow groundwater and transport it for discharge to Biscayne Bay. These processes are included in the conceptual model.

Numerical Model

The USGS model is based on a previously developed regional-scale model (Lohmann et al. 2012-TN1429) that integrated surface-water and groundwater processes to study flows into and out of Biscayne Bay (Figure G-3). The original model's intent was to examine regional-scale processes that influence Biscayne Bay salinity.

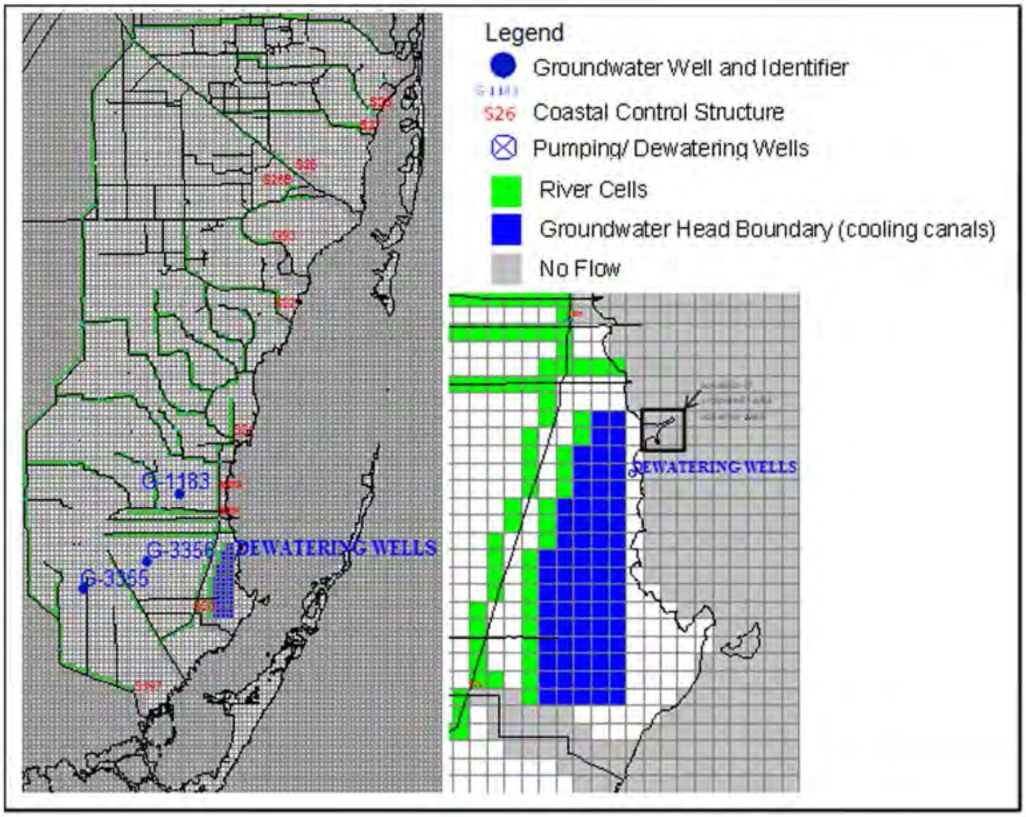


Figure G-3. USGS Model Domain and Grid Used for Salinity Analysis of RCW Pumping at Turkey Point. ***An inset of the grid in the vicinity of Turkey Point is included. (Taken from NRC 2014-TN3078, Figure 2)***

Both model studies (Lohmann et al. 2012-TN1429; NRC 2014-TN3078) covered the period January 1996 through December 2004, a duration of 9 years. This simulation period was chosen because the Lohmann et al. model was calibrated for this period. The canal inflows, precipitation, and meteorology applied in the NRC-commissioned study are the same as those used by Lohmann et al. (2012-TN1429). For the regional-scale analysis, the model used a 500 m by 500 m grid spacing to define the physical features of the model domain. The model uses 20 vertical layers that represent the whole aquifer, with one of those layers representing Biscayne Bay. The surface layer is 4 m thick, the second layer is 1.5 m thick, and the remaining layers are 2.75 m thick. The NRC commissioned study (NRC 2014-TN3078) updated the previously developed model to include (1) the cooling canals and (2) the representation of two temporary dewatering wells during the construction period at the proposed site for the Unit 6 and 7 reactors for the scenarios. Pumping from the dewatering wells was only included in the base case. The cooling canals were represented in the model by 70 cells for which the water-surface elevations were specified and the salinity was set to a constant 65 psu. The two dewatering wells were represented in the model in one cell and were set to pump for a 6-month period (June 2001 through December 2001). The inclusion of these two updates into the Lohmann et al. (2012-TN1429) model constituted the base case of the analysis.

For the evaluation of RCW pumping, the entire RCW system was represented in the model by four grid cells. When active, the total RCW pumping rate was set to 490,536 cubic meters per day (m^3/d) (90,000 gpm). Model inputs that were varied in the commissioned study were (1) the RCW withdrawal layer (layer 3 or layer 5) in the scenarios, (2) the distribution of RCW well intakes in model, (3) the RCW pumping period, and (4) vertical hydraulic conductivities and leakage of the subsurface layers (NRC 2014-TN3078). The commissioned report did not present results for all combinations of the varied inputs because the modeling results of some scenarios were not significantly different from the ones that were included in the report. The analyses ultimately included were for RCW groundwater extraction from layer 3 and for the well intakes distributed along the RCW intake pipes (NRC 2014-TN3078).

In regard to the RCW pumping periods, the commissioned study examined (1) continuous pumping (the most conservative pumping option), (2) 90-day pumping during the annual dry period, and (3) alternating periods of 30 days pumping and 90 days no pumping (NRC 2014-TN3078). Each of these pumping periods is longer than the 60 days mentioned in Section 5.2.1.2 of this EIS as the limit currently proposed by FDEP as the permit condition for operating the wells. Consequently, each pumping period analyzed by the commissioned study (NRC 2014-TN3078) is more conservative than the FDEP conditions would actually permit. Ultimately, the review team included only the continuous-pumping and 90-day-pumping scenarios, because they were the most conservative of the three pumping scenarios examined by USGS. Continuous pumping does not allow any time for system recovery as would occur with the alternating pumping and no-pumping scenarios.

In regard to vertical conductivities, the NRC (2014-TN3078) study examined (1) the values used in the previous study (Lohmann et al. 2012-TN1429), which were used in the base case, (2) decreased vertical conductivity in the subsurface layers plus decreased leakage between surface-water and groundwater layers, and (3) decreased vertical conductivity in all subsurface layers except layers 3, 4, and 5 (RCW extraction layers). The review team only included the first of these realizations because it was based on the calibrated model of the Biscayne Bay and aquifer system. Also, the review team expects that any reduction of vertical conductivity would decrease the effect of RCW pumping on Biscayne Bay salinity.

The commissioned study specified that initial conditions used to start the scenario analyses be the same as the final state of the base case in order to provide each of the scenarios with a common starting point. The specified initial conditions include heads, water levels, and salinity.

Results

The alterations on the salinity in the groundwater and in Biscayne Bay predicted by the USGS model are discussed in the following sections.

RCW Pumping Effects on Groundwater Salinity

At the end of the base case run, the predicted potentiometric surface showed a slight depression along the coast near Turkey Point that is the result of pumping the RCWs in the area that is included in the model (Figure G-4; NRC 2014-TN3078). Layers 2 and 3 were selected for plotting because they are just below Biscayne Bay and any canals, so that any groundwater effects from RCW pumping on Biscayne Bay will be transmitted through these two layers. For the continuous-RCW-pumping scenario, the USGS model predicted a cone of depression that surrounded the RCWs and extended laterally for several hundred meters (NRC 2014-TN3078).

The model predicted that the cone of depression for the continuous-pumping case would be present at the end of the simulation because there was no opportunity for recovery. For the 90-day-pumping case, the model predicted that the cone of depression would not be evident at the end of the simulation because the system would have fully recovered after 275 days of no pumping.

The effect on regional groundwater potentiometric head to the northwest and west of the RCWs and Turkey Point site was predicted to be minimal. Sensitivity tests with vertical conductivity predicted there could be slightly larger changes in potentiometric head, which were attributed to a slightly landward movement of higher density (higher salinity) groundwater (NRC 2014-TN3078). The review team notes that these ranges of potentiometric head were within the range of uncertainty and predictive error of the model.

The salinity results at the end of the simulations for layers 2 and 3 within the groundwater system are shown in Figure G-5 (NRC 2014-TN3078). The blue regions landward of the coast represent freshwater. The green regions are where the marine water was predicted to infiltrate into the first two groundwater layers. The red zones are the hypersaline (high density) plume originating from the cooling canals.

For the area north of the hypersaline plume Figure G-5 the model predicts that in the continuous-pumping case, salinity would decrease landward of Turkey Point in comparison with the base case, while in the 90-day-pumping case, there would be a smaller decrease in salinity. For the continuous-pumping case the model predicts an increase in salinity in layer 3 (Figure G-5) directly under Turkey Point (essentially in a single grid cell), and a decrease in salinity north of the hypersaline plume. For the 90-day-pumping scenario, a decrease in salinity north of the hypersaline plume was also predicted, though the decrease was smaller than for continuous pumping. The smaller change results from the 9 months of recovery per year that is modeled in the 90-day-pumping scenario.

The change in groundwater salinity predicted by the model was assessed by finding the greatest differences for each grid cell between a scenario and the base case (NRC 2014-TN3078). The results at the end of the simulations of the greatest salinity differences for the continuous-pumping and 90-day-pumping scenarios are shown in Figure G-6. Note that the maximum predicted salinity differences for each model grid cell would not necessarily occur in the same layer, but this analysis provided an overall trend of salinity change. The predicted penetration into the groundwater system of the hypersaline plume from the cooling canals produced the ring of high positive change that surrounds the Turkey Point facilities. The model predicted greater freshening of the groundwater under the continuous-pumping scenario than under the 90-day-pumping scenario. The freshening is shown by a negative change in salinity centered northwest of Turkey Point. The predicted change, with the inclusion of RCW pumping, likely results from the withdrawal of a portion of the hypersaline plume from the groundwater system. Because the model conserves mass, withdrawal of groundwater results in water being drawn from other sources to replace it, and the freshening in this region could be due to predicted inflow from either freshwater or marine waters.

Examination of the total volumetric exchange between surface waters and groundwater showed that for the base case the model predicted a tendency toward discharge from the aquifer to Biscayne Bay (Figure G-7), though the base case rates were small (<500 m^3/d). Landward of

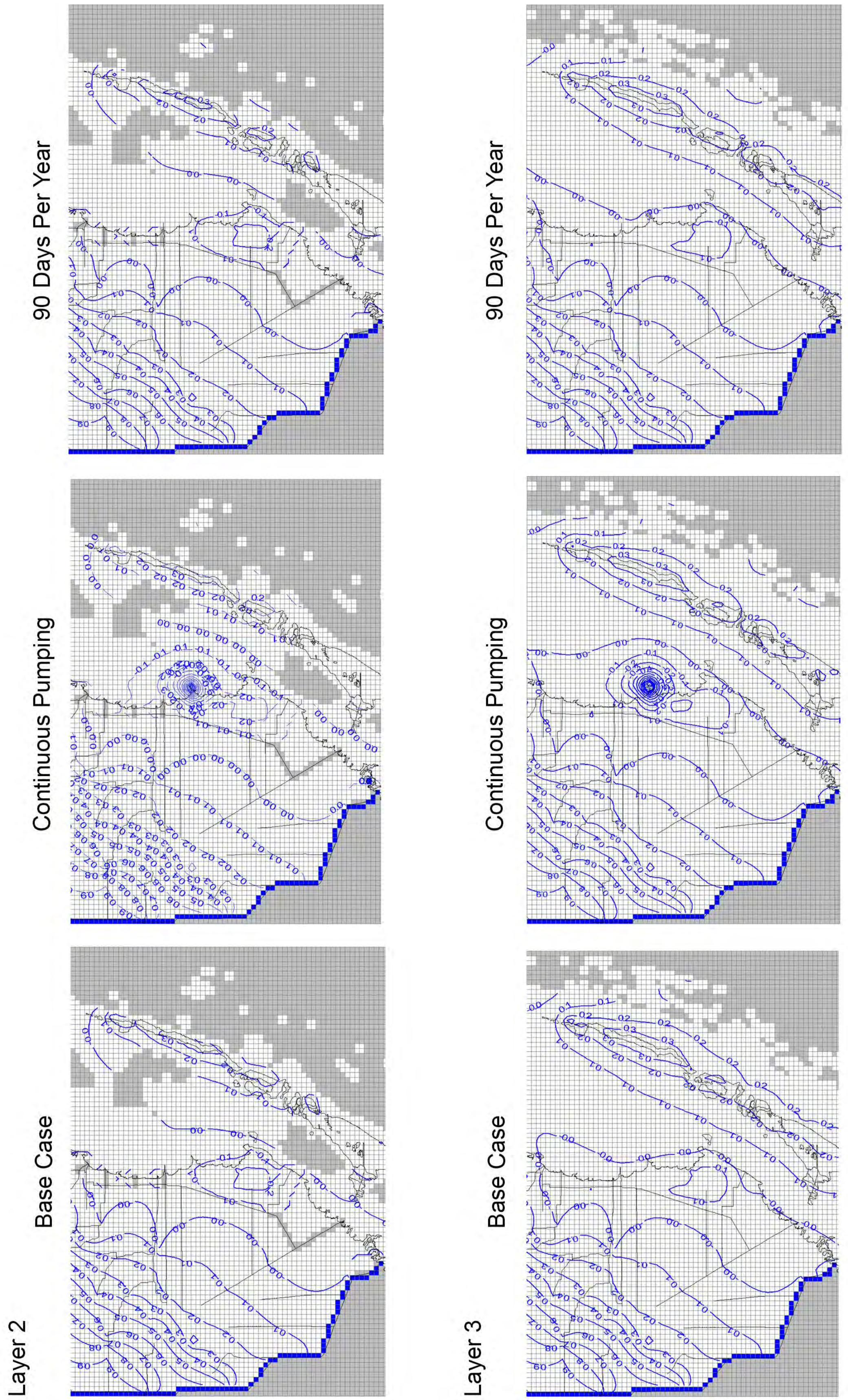


Figure G-4. Potentiometric Surfaces for Base Case and Continuous-Pumping and 90 d/yr Pumping Scenarios at the End of the 9-Year Simulations. ***Units are meters of elevation (NAVD88). (Taken from NRC 2014-TN3078, Figure 5, Figure 6A, and Figure 7)***

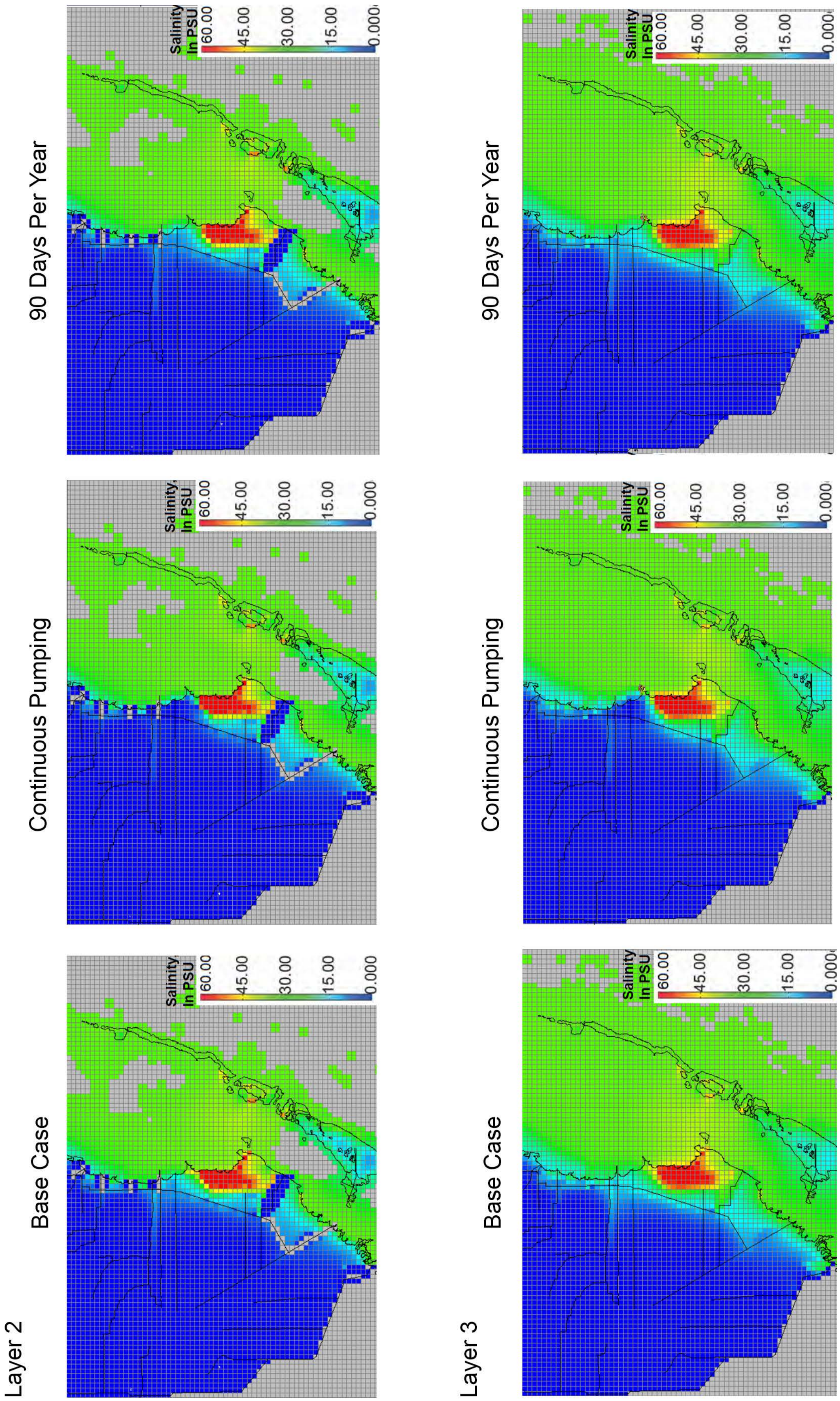


Figure G-5. Salinities for Base Case, Continuous-Pumping, and 90 d/yr Pumping Scenarios at the End of the 9-Year Simulations. ***Units were practical salinity units. (Taken from NRC 2014-TN3078, Figure 17, Figure 18A, and Figure 19)***

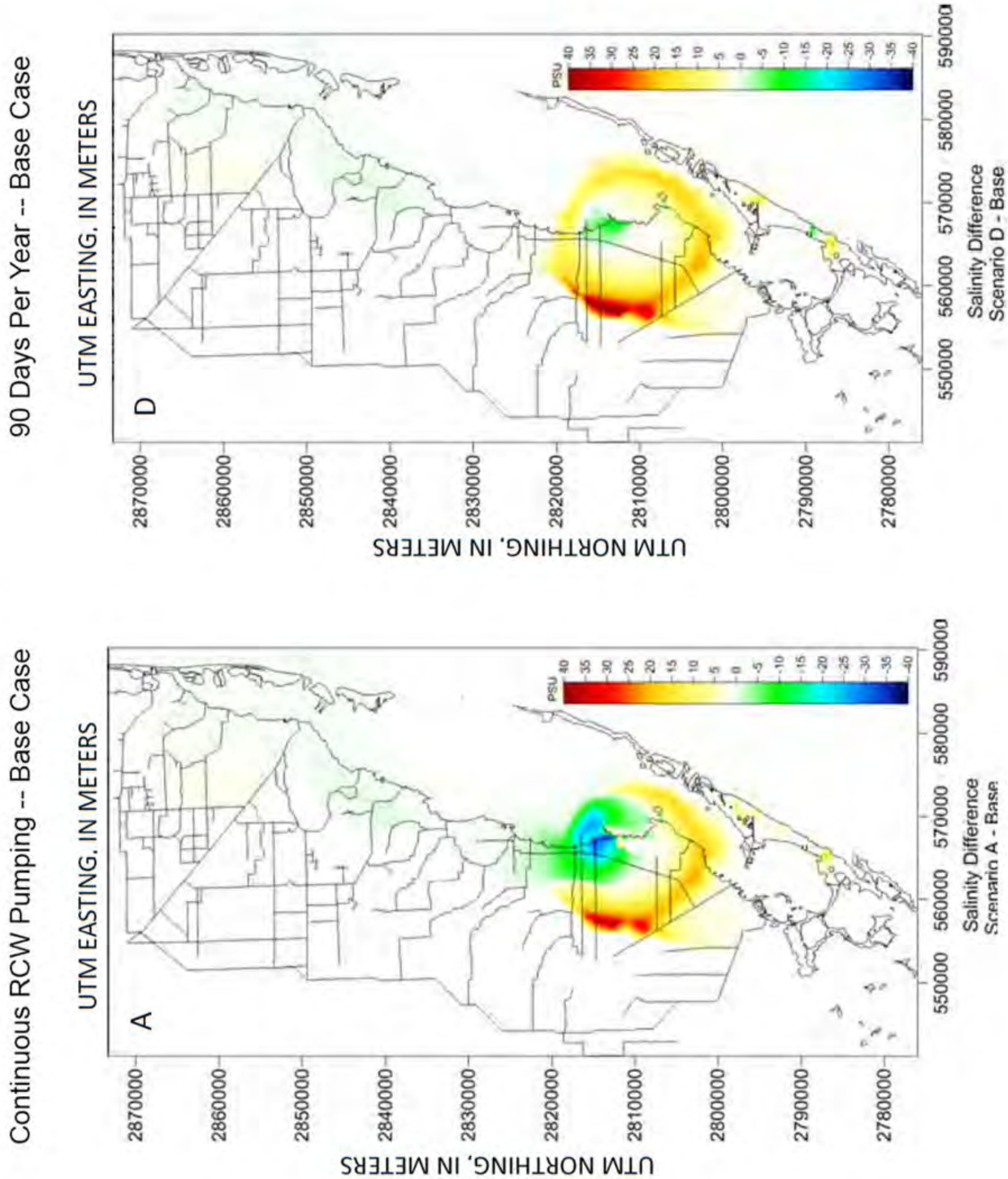


Figure G-6. Differences between Maximum Salinities between the Continuous RCW-Pumping Case and the Base Case and between the 90 d/yr Pumping Case and the Base Case (Taken from NRC 2014-TN3078, Figure 16b)

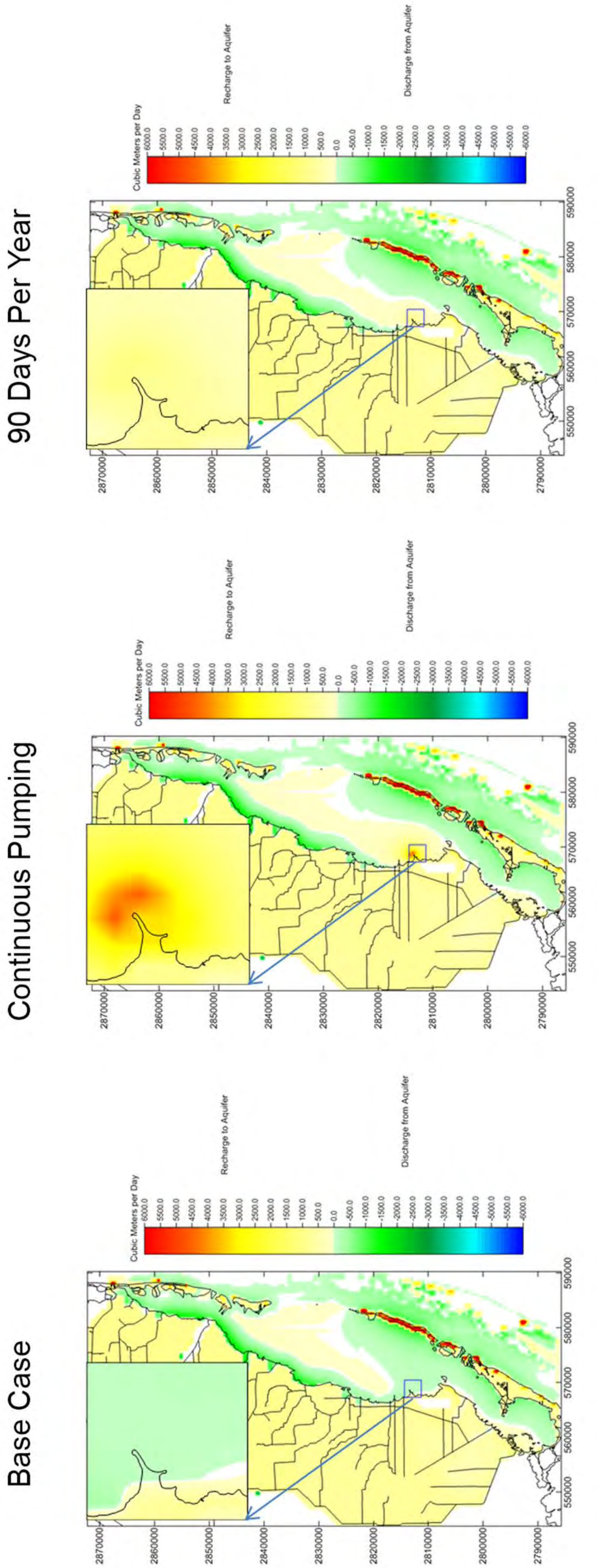


Figure G-7. Total Leakage (m^3/d) at the End of the Simulation for the Base Case, Continuous RCW-Pumping, and 90 d/yr Pumping. (Taken from NRC 2014-TN3078, Figure 26 and Figure 27)

Biscayne Bay, the total volumetric exchange predicted for the base case tended toward recharge, as expected with the occurrence of precipitation and infiltration into the land. For the continuous-pumping case, the model predicted a tendency for high recharge (inflow) from Biscayne Bay into the aquifer, as expected with RCW pumping, with rates locally around 5,000 m^3/d. For the 90-day-pumping scenario, the results tended toward recharge but without the higher localized recharge rate predicted with continuous pumping.

RCW Pumping Effects on Biscayne Bay Salinity

To investigate the salinity response in Biscayne Bay to RCW pumping, the review team examined model output results at locations near Turkey Point (NRC 2014-TN3078) corresponding to the measurement stations reported in this EIS Table 2-9, as well as three additional stations further north and close to Turkey Point (Figure G-8). Only the continuous-pumping scenario was included in the examination of Biscayne Bay salinity because the USGS model predicted the largest effects on groundwater for this scenario and it provided an upper bound of salinity variation of all potential RCW-pumping scenarios.

Time series of salinity results and salinity differences for the seven stations are shown in Figure G-9. Generally, the model predicted that salinity would exhibit seasonal variation due to freshwater inflows from drainage canals into Biscayne Bay, while increases in salinity would result from evaporative losses. For both the base and continuous-pumping cases, the largest seasonal variations were predicted at the northernmost locations (station A and B), with the smallest seasonal variations around Turkey Point (station C). Model results for locations closest to the measurement stations exhibited an intermediate range of seasonal variation. The north-south differences in seasonal salinity variation was likely caused by the northern portion of the region receiving relatively larger inputs of freshwater inflows from canals during the wet season.

The review staff computed the summary statistics (Table G-22) for salinity time series for the stations shown in Figure G-9. As suggested by the variation seen in the time-series plots, the standard deviations were largest for the northernmost stations examined. The minimum and maximum salinities also varied by location, with the largest maximum and smallest minimum predicted for the northernmost stations. For the tidal boundary, the primary source of water for Biscayne Bay, the model had the salinity set to 35 psu (Lohmann et al. 2012-TN1429). In comparison with the measured stations (EIS Table 2-9), the maximum salinities from the NRC commissioned study were smaller than observed at the measured stations (NRC 2014-TN3078). However, the periods from which the data were available were not the same between the measured data (2005 onward) and model results (2004 and earlier), so that direct comparisons are not possible.

The review team finds that the salinity differences between the continuous-pumping and base cases varied between +2 psu to -2 psu, but with most variations between +1 psu and -1 psu (Figure G-9). The model predicted an anomalous increase within the first year (1996) because of the onset of pumping, but this was wiped out by the start of 1997. Variations beyond +2 psu and -2 psu were predicted to be of very short duration.

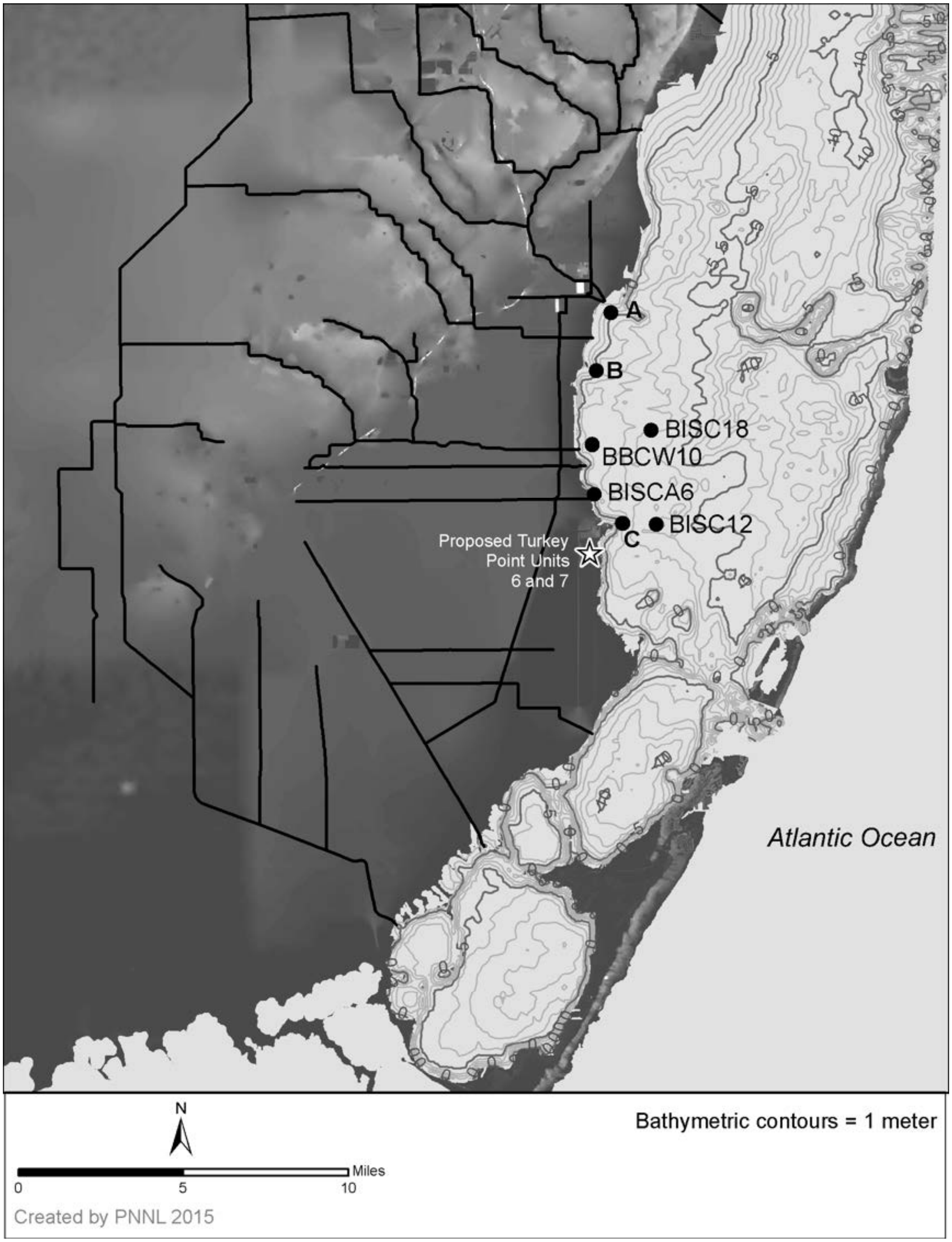
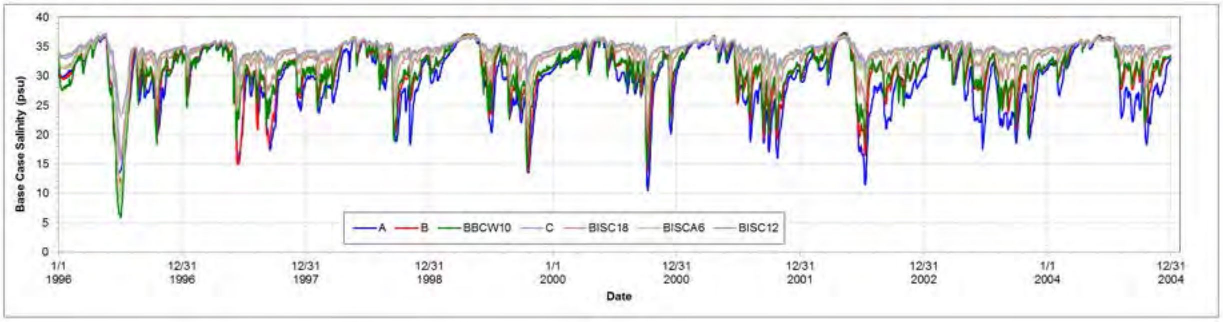
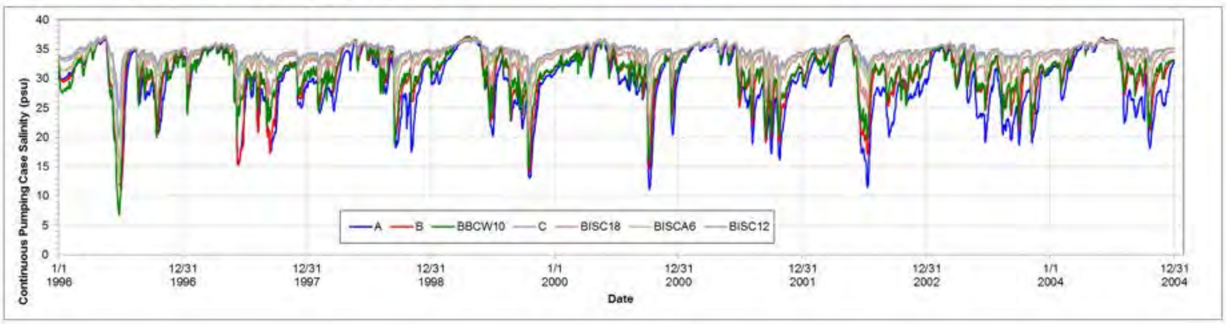


Figure G-8. Locations Where Salinity Time Series from USGS Model Were Examined

Base Case



Continuous Pumping Case



Sailinity Differences

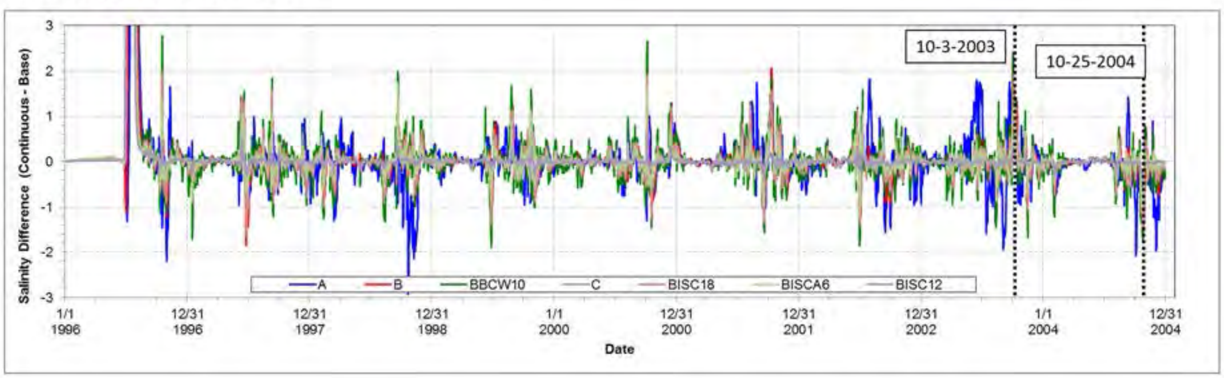


Figure G-9. Salinity and Salinity Differences (psu) from USGS Model at Locations Indicated in Table G-22. ***The dashed lines indicate the times for which spatial variations were examined (see Figure G-10 and Figure G-11).***

Table G-22. Summary of Predicted Salinity for the Period January 1, 1997 through December 31, 2004 near the Turkey Point Site at Stations Shown in Figure G-9

Station	Number of Time Intervals	Mean (psu)	Standard Deviation (psu)	Minimum (psu)	Median (psu)	Maximum (psu)
Base Case						
A	2,922	29.62	5.08	10.48	30.18	37.35
B	2,922	31.24	4.21	13.81	31.84	37.24
BBCW10	2,922	31.66	3.62	14.36	32.02	37.05
BISC18	2,922	33.56	2.34	20.92	33.98	36.91
BISCA6	2,922	34.41	1.48	24.75	34.62	36.97
C	2,922	34.67	1.14	28.26	34.81	36.90
BISC12	2,922	34.76	0.94	29.27	34.86	36.65
Continuous-Pumping Case						
A	2,922	29.58	5.09	11.19	30.13	37.32
B	2,922	31.22	4.20	14.02	31.81	37.24
BBCW10	2,922	31.65	3.60	14.68	31.95	37.06
BISC18	2,922	33.55	2.32	21.03	33.97	36.93
BISCA6	2,922	34.41	1.46	25.20	34.62	36.99
C	2,922	34.67	1.13	28.26	34.81	36.92
BISC12	2,922	34.76	0.94	29.24	34.86	36.70

psu = practical salinity units

Source: NRC 2014-TN3078

To investigate the spatial distribution of salinity and salinity differences, the review team examined salinity at two different characteristic periods. One was selected that had positive salinity differences as shown in Figure G-9, and another was selected that had negative salinity differences as shown in Figure G-9. During both of these periods, the salinities along the nearshore north of Turkey Point were lower than those typically found for marine waters, being on the order of 20 psu compared to 35 psu specified at the model's tidal boundary with the Atlantic Ocean (Figure G-10 and Figure G-11). Examination of the salinity differences from the October 3, 2003 results showed a small increase in salinity in southern Biscayne Bay (Figure G-10), with only a small patch of nearshore water predicted to have a salinity increase on the order of +2 psu. In contrast, the results for the October 25, 2003 period showed a small decrease in salinity (Figure G-11), with a small patch of nearshore water predicted to have a salinity decrease on the order of -1.5 psu.

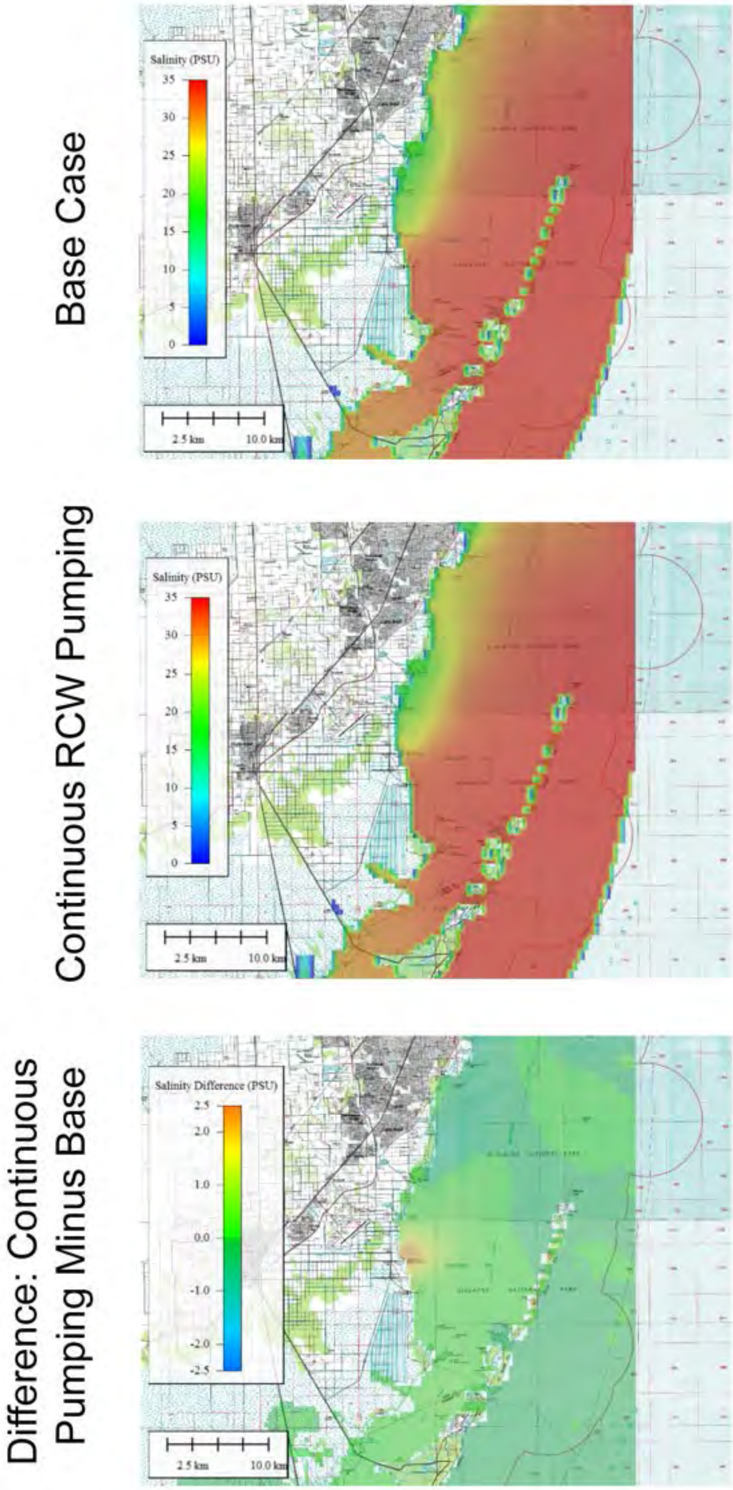


Figure G-10. Surface-Water Salinities at the Time with the Largest Difference North of Turkey Point between the Base Case and Continuous-Pumping Scenario on October 3, 2003. ***Units are psu (practical salinity units).***

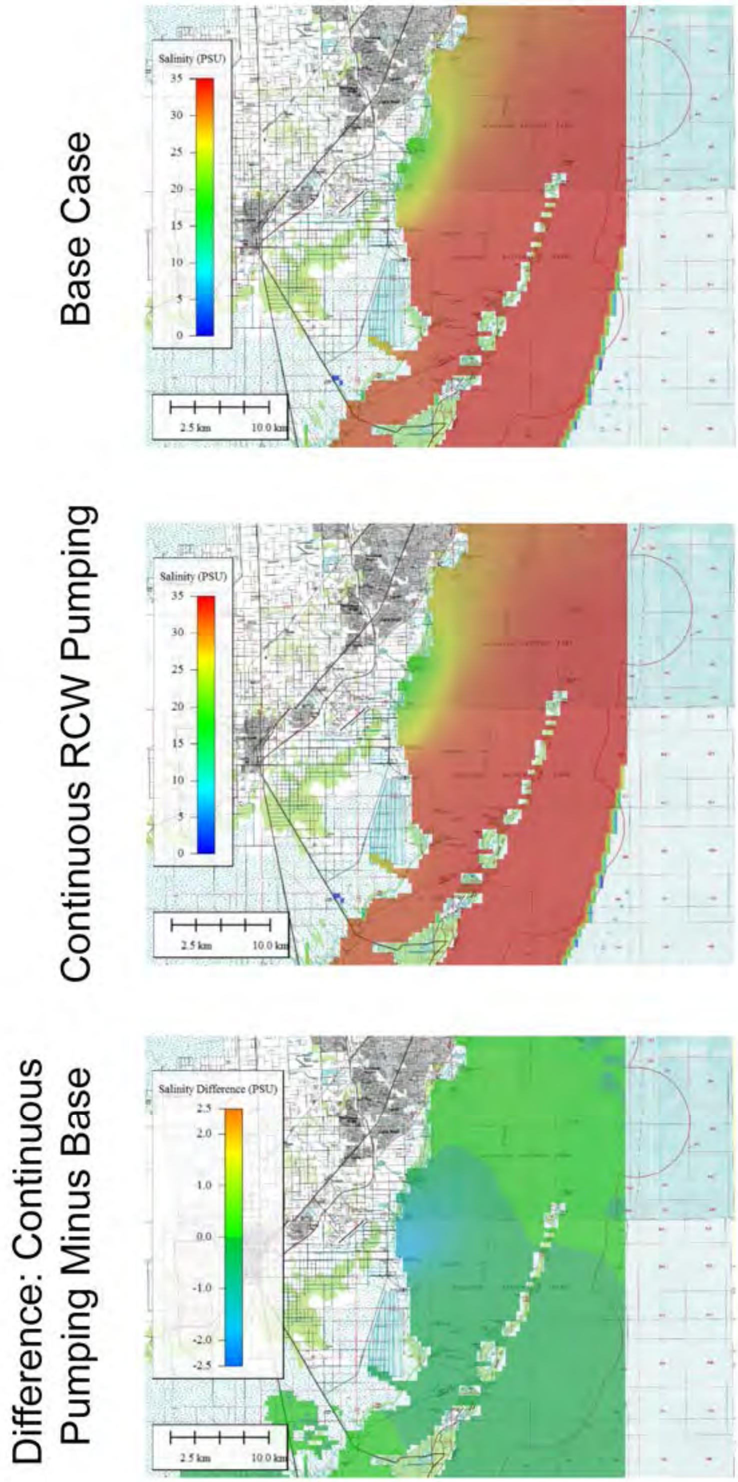


Figure G-11. Surface-Water Salinities at the Time with Largest Decreases North of Turkey Point between the Base Case and Continuous-Pumping Scenario on October 25, 2004. ***Units are psu (practical salinity units).***

G.3.2.3 Summary of Review Team Focused Modeling

To further confirm the review team's understanding of the groundwater hydrodynamics and to consider whether certain actions proposed after the two earlier modeling studies were completed would alter the earlier conclusions documented by the review team in their draft environmental impact statement (EIS, NRC 2015-TN4444), the review team performed a third modeling analysis. This third modeling analysis is discussed in this section and presented in detail by Oostrom and Vail (2016-TN4739).

The review team used the water-salt-energy mode of the STOMP (Subsurface Transport Over Multiple Phases) simulator to perform the simulations (White and Oostrom 2006-TN4808). The applicable governing equations are the component mass-conservation equation for water and salt and the energy conservation equation. The simulator allows for the consideration of density-driven flow and temperature effects caused by the seepage of warm hypersaline water from the unlined cooling-canal system (CCS) into the saline Biscayne aquifer. The review team based the model configuration on an earlier cross-sectional model published by Hughes et al. (2010-TN1545). The two-dimensional (2D) model is 46 km long and extends 35 m vertically. To facilitate simulation of the effects of radial collector well operation, the review team also developed a three-dimensional (3D) model, which represents a 2 km wide extension of the 2D model.

The review team performed a steady-state simulation with a Biscayne Bay hydraulic head of 0.2 m and a west boundary head of 1.05 m to obtain the initial conditions for both the 2D and 3D simulations. The long-term (10,000-year) simulations yielded a typical salt intrusion front, which extends below the CCS. For the subsequent hypersaline water infiltration simulations, the review team used the same boundary conditions as those proposed by Hughes et al. (2010-TN1545) for hydraulic heads and temperature.

The 2D simulations predict several main observations, as follows:

- CCS operation with warm 70 g/L hypersaline water leads to the development of a large subsurface plume.
- Reducing the CCS salt concentration leads to a stable displacement of hypersaline water from the CCS subsurface.
- Increasing the hydraulic head in the L-31E Canal limits westward migration of the hypersaline plume.
- Increasing the west boundary hydraulic head (indicative of increased recharge) results in a compression of the hypersaline plume at the west side of the CCS.
- Decreasing the west boundary hydraulic head (indicative of reduced recharge) has the opposite effect, and leads to additional migration of the hypersaline plume in the western direction.
- During sea-level rise, infiltrating saltwater from the Biscayne Bay pushes the hypersaline water toward the CCS subsurface. Over time, the interface between hypersaline water originating from the CCS and seawater becomes more sharply defined and more vertical.

The 3D simulations predict several main observations, as follows:

- Periodic extraction using the RCW system leads to fluctuating salt concentrations in the radial collector wells.
- During pumping, the salt concentrations initially increase because of advective transport of hypersaline water through the Upper Higher Flow Zone; the salt concentrations then decrease because of the influence of extracted Biscayne Bay saltwater.
- During intervals between periods of pump operation, salt concentrations slightly increase due to diffusion of hypersaline water eastward; the radial collector well salt concentrations do not change significantly from year to year.
- RCW pumping increases the concentration gradients between the hypersaline plume below the CCS and Biscayne Bay saltwater in the upper parts of the aquifer and removes some of the hypersaline water from the Fort Thompson formation; the extracted volumes originate largely from Biscayne Bay (>95 percent); pumping rate reduction (up to 10 percent of maximum) and duration reduction (50 percent) do not considerably influence collector well salt concentrations. This result indicates that the proposed RCW operation with a 86,400 gal/min withdrawal rate over 60 days per year would completely dominate flow and transport adjacent to the RCWs, because reasonable variations in the rate and duration do not considerably influence collector well salt concentrations.
- Boundary condition modifications (i.e., L-31E Canal head and west boundary head increases) applied to the west of the CCS do not influence RCW extraction behavior.
- Seawater rise in Biscayne Bay leads to decreasing RCW saltwater concentration over time because the increasing Biscayne Bay hydraulic head displaces hypersaline water toward the CCS subsurface.
- Operation of remediation wells in the Lower Higher Flow Zone below the Interceptor Ditch does not influence extracted RCW salt concentrations.
- Salt concentrations in the remediation wells are predicted to increase to CCS salt levels within a year of remediation pumping.
- Freshening of the CCS surface water results in reduced RCW salt concentrations with relatively minor (<1 g/L) fluctuations.

Without doubt, some perturbations of the baseline boundary conditions result in significantly altered environmental baselines. However, while the operation of the RCWs would change the incremental impacts of the RCWs on the salinity distribution of the Biscayne aquifer, the alterations would remain at levels that may only be detectable within the immediate vicinity of the RCWs. While the numerical model analysis predicts a slight westward movement of some hypersaline water as a result of the operation of the RCWs, there is no plausible upward impelling force above the RCWs that would result in hypersalinity moving into the Bay as a result of RCW operation. As the review team acknowledged in the EIS Section 2.3.1, when the water-surface elevation in the cooling canals exceeds that in the Bay, the water will follow the gradient of the impelling force into the Bay and may contribute to salinity in the Bay. Both of the above effects also apply for other dissolved constituents in the hypersaline plume, including nutrients and tritium.

Although the primary focus of the modeling reported here is on the incremental effects of the RCWs on the Biscayne Bay, the review team also acknowledges the cumulative impacts of other changes, including those from sea-level rise and possible future regulatory actions. While the scenarios considered in this analysis were designed to be bounding for sea-level rise and possible regulatory actions, they also provide a basis for assessing the cumulative impacts. NRC lacks authority to impose additional mitigation measures regarding surface water conditions subject to State regulation. However, additional mitigation actions proposed by state and county agencies would presumably improve the baseline environment. Because the modeling results predict that the incremental effect of the operation of the RCWs remains minor, the cumulative effects would also remain minor.

The review team's modeling predicts minor localized alterations in salinity distribution due to RCW operation, and these results suggest that the operation of the RCWs is unlikely to interfere with any of the mitigation measures proposed to address the conditions in the cooling canals or the underlying Biscayne aquifer.

G.3.3 Confirmatory Calculations of Potential Upward Migration of Injectate from the Boulder Zone of the Lower Floridan Aquifer

As described in Chapter 5 of the EIS, blowdown and other liquid wastes from the proposed plants would be injected into the Boulder Zone of the Lower Floridan aquifer. Use of reclaimed water as a makeup water source would result in injectate that is buoyant because of its lower density compared to the saline water in the Boulder Zone. FPL conducted performance assessment modeling of potential upward migration of injectate based on the reclaimed water source (FPL 2014-TN4069) in support of the safety and environmental analysis of the proposed plants. The analyses consisted of two main scenarios that were considered feasible:

- Normal Operation Scenario: Upward migration of contaminants through a competent middle confining unit (MCU) under expected hydrogeologic conditions. The normal operation scenario assumes that no system failures occur, e.g., no injection well failure or subsurface loss of confinement beyond the FPL property area.
- Off-Normal Operation and Inadvertent Intrusion Scenario: Bypass of the MCU at a location 2.2 mi from the wastewater injection site through a hypothetical high-conductivity channel or failed well (conduit), where a water-supply well is withdrawing water from the upper Floridan aquifer directly above the MCU conduit. The hypothetical water-supply well provides direct access to the upper Floridan aquifer, bypassing the intermediate confining unit and the Biscayne aquifer.

The FPL analyses were focused on the fate and transport of radionuclides in the injectate, but also demonstrate the potential movement of chemical species in the injectate. The FPL analyses were based on conservative assumptions that would tend to maximize the migration of effluent. The off-normal and inadvertent intrusion scenario "bounded" some other feasible scenarios such as bypass of the MCU at the injection site because it resulted in shorter travel times.

The review team performed a separate confirmatory analysis of these scenarios, which resulted in concentrations of radionuclides at receptor locations similar to those calculated by FPL. The confirmatory analyses were performed through spreadsheet calculations as described below.

G.3.3.1 *Normal Operations: Upward Migration through a Competent MCU Layer Scenario*

The confirmatory calculation was based on transport equations described by Post et al. (2007-TN4145) and used the parameters shown in Table G-23. The effective vertical hydraulic conductivity of the MCU was based on the harmonic mean of the values determined from testing of core samples from the MCU at the EW-1 exploratory well (FPL 2012-TN1577). The harmonic mean is the most appropriate hydraulic conductivity value for fluid flow perpendicular to a layered system (Freeze and Cherry 1979-TN3275). Lower porosity decreases travel time in the calculations, so a conservatively low porosity value of 0.2 was used. The core analysis results from EW-1 are shown in Table G-24.

Table G-23. Parameters and Results for the Confirmatory Analysis of Upward Migration through a Competent MCU Layer

Parameter	Value	Description
z1[(a)]	-2,900 ft	top of injection zone (referenced to sea level [positive upward])
z2[(b)]	-1,400 ft	bottom of USDW aquifer (referenced to sea level [positive upward])
ρ1[(c)]	62.230 lb_m/ft^3	water density at top of injection zone
ρ2[(d)]	62.792 lb_m/ft^3	water density at bottom of USDW aquifer
h1[(e)]	328.1 ft	piezometer head elevation at top of injection zone
h2[(f)]	188.6 ft	piezometer head elevation at bottom of USDW aquifer
Keff[(g)]	1.82E-07 ft/s	effective hydraulic conductivity
ρa	62.5 lb_m/ft^3	calculated average density over the migration interval
hf1	328.1 ft	fresh water head at top of injection zone
hf2	203.0 ft	fresh water head at bottom of USDW aquifer
Δhf	-125.1 ft	calculated freshwater head difference
Δz	1,500 ft	calculated elevation difference
Δhf/Δz	-0.0834	calculated fresh water gradient
(ρa-ρf)/ρf	0.0045	calculated density gradient
qz	1.24E-3 ft/d	calculated groundwater flux (positive upward)
Θeff[(h)]	0.2	effective porosity along flow path
tt	663 yr	calculated travel time from z1 to z2
Distance in 100 yr	226 ft	calculated vertical migration distance in 100 yr
Linear Velocity	0.00619 ft/d	calculated
C1	1	unit concentration of injectate at top of injection zone
t-half	12.3 yr	tritium half-life
C2	5.92E-17	calculated fraction of unit tritium concentration after 663 yr

Note: flux calculated based on Post et al. (2007-TN4145)
(a) FSAR Fig. 2.4.12-245
(b) FSAR Fig. 2.4.12-246
(c) minimum FSAR value assumed to be freshwater density = 62.2 lb_m/ft^3
(d) 10,000 mg/l TDS @ 20°C
(e) Starr et al. (2001-TN1251), Injection Zone High Value
(f) Starr et al. (2001-TN1251), Upper Monitoring Low Value (wells being purged were not considered)
(g) Approximate maximum MCU Property Estimate
(h) Minimum value from Reese (1994-TN1439)

Source: FPL 2014-TN4069 unless otherwise noted

Results of the "normal operations" scenario confirmed the FPL result that the injectate would move less than 300 ft upward into the MCU over a 100 yr period. The calculations also resulted in radionuclide concentrations at receptor locations similar to those calculated by FPL (2014-TN4069).

Table G-24. Core Analyses from the EW-1 Exploratory Well

Sample Depth (ft bpl)	Vertical Hydraulic Conductivity (cm/sec)	Horizontal Hydraulic Conductivity (cm/sec)	Specific Gravity	Total Porosity (%)
2026.4-2027.0	3.30E-06	3.20E-06	2.71	27.4
2027.0-2027.5	3.70E-04	7.80E-04	2.70	35.0
2029.4-2030.4	1.00E-05	2.80E-05	2.71	33.6
2030.4-2031.3	3.00E-05	1.30E-04	2.71	36.6
2036.2-2036.7	7.60E-05	1.10E-04	2.72	35.5
2036.7-2037.9	NA	NA	NA	NA
2295.2-2296.0	1.90E-04	1.00E-04	2.74	39.5
2296.0-2296.75	8.40E-05	5.90E-04	2.72	37.9
2296.75-2297.5	1.00E-04	1.00E-04	2.72	38.5
2399.9-2400.9	5.40E-04	5.40E-04	2.70	38.7
2576.0-2577.0	1.90E-04	2.50E-04	2.71	41.4
2639.3-2639.7	1.60E-06	8.40E-05	2.69	33.7
2639.7-2640.2	NA	NA	NA	NA
2645.1-2645.5	1.40E-05	6.20E-06	2.70	36.9
2645.5-2646.5	NA	NA	NA	NA
2652.0-2652.8	2.80E-06	4.60E-06	2.71	34.5
2652.8-2653.5	2.30E-06	2.50E-05	2.71	33.2
2675.1-2675.6	2.70E-04	2.90E-04	2.71	39.5
2675.6-2676.1	NA	NA	NA	NA
2676.1-2677.0	1.10E-06	5.30E-04	2.72	43.4
Arith. Mean	**1.18E-04**			
Geom. Mean	**2.86E-05**			
Harmonic Mean	**5.54E-06**			

Source: FPL 2012-TN1577

G.3.3.2 Off-Normal Operation and Inadvertent Intrusion Scenario:

FPL's safety analysis (FPL 2014-TN4069) also considered a case with a hypothetical water-supply well being drilled into the upper Floridan (USDW) aquifer and a simultaneous bypass/failure of the MCU at the same location 2.2 mi from the wastewater injection site. The 2.2 mi distance is based on the nearest privately owned parcel. This scenario makes the off-normal operation assumption that there is a high-permeability connection through the MCU between the injection zone and the upper Floridan aquifer located 2.2 mi from Turkey Point wastewater injection site. This is combined with an inadvertent intrusion scenario that places a water-supply well in the upper Floridan aquifer directly above the conduit through the MCU. The FPL analysis showed that the transit time through the Boulder Zone from the Turkey Point injection wells to the offsite location 2.2 mi away would be 21 years (FPL 2014-TN4069). The staff's confirmatory calculation showed that at the expected injection rate of 12,460 gpm, and a conservatively low porosity of 0.2, the injectate plume would reach the hypothetical offsite location in 23.5 years.

The safety analysis was conservative in that it did not account for transit time through the MCU and it did not account for dilution of contaminants within the Upper Floridan aquifer. It assumed that 100 percent of the water pumped by the water-supply well would be from the Boulder Zone with no dilution in the APPZ or the Upper Floridan aquifer.

The staff performed a calculation of expected flux through the MCU and dilution in the Upper Floridan aquifer using the maximum MCU hydraulic conductivity from the range of values shown in Table G-24 for the area of the enhanced vertical flow pathway. This calculation assumed a pathway size of 0.3 m^2 to match the approximate size of a failed borehole seal. The results of the leakage calculations for this scenario were an upward velocity of 1,245 m/yr and eventual discharge of 54 gpd of injectate into the Upper Floridan aquifer. It was assumed that this volume of injectate would mix over a width of 10 m and 1 percent of the Upper Floridan aquifer depth before being brought to the surface through a water-supply well. This was based on an Upper Floridan aquifer transmissivity equal to the minimum of the range of values, which would minimize the calculated dilution factor. This very conservative mixing scenario results in a dilution factor of 0.93, meaning that 93 percent of the water from the well would be injectate. This calculation represents a conservative case in multiple ways, including the assumption that a water-supply well would be placed such that it would exclusively be pumping water from the assumed mixing zone directly above a high-conductivity conduit from the injection zone. An upward velocity of 262 ft/yr was estimated by Maliva et al. (2007-TN1483) for an enhanced vertical flow feature at an injection site in Palm Beach County compared to the 1,245 ft/yr upward velocity from this analysis.

Table G-25. Parameters and Results for the Confirmatory Analysis of Upward Migration Through a Conduit in the MCU and into the Upper Floridan Aquifer

Parameter	Value	Description
z1[(a)]	-2,900 ft	top of injection zone (referenced to sea level [positive upward])
z2[(b)]	-1,400 ft	bottom of USDW aquifer (referenced to sea level [positive upward])
ρ1[(c)]	62.230 lb_m/ft^3	water density at top of injection zone
ρ2[(d)]	62.792 lb_m/ft^3	water density at bottom of USDW aquifer
h1[(e)]	328.1 ft	piezometer head elevation at top of injection zone
h2[(f)]	188.6 ft	piezometer head elevation at bottom of USDW aquifer
Keff[(g)]	3.28E-04 ft/s	effective hydraulic conductivity
ρa	62.5 lb_m/ft^3	calculated average density over the migration interval
hf1	328.1 ft	fresh water head at top of injection zone
hf2	203.0 ft	fresh water head at bottom of USDW aquifer
Δhf	-125.1 ft	calculated freshwater head difference
Δz	1,500 ft	calculated elevation difference
Δhf/Δz	-0.0834	calculated fresh water gradient

Table G-25. (contd)

Parameter	Value	Description
(ρa-ρf)/ρf	0.0045	calculated density gradient
qz	2.24 ft/d	calculated groundwater flux (positive upward)
Θeff[h]	0.2	effective porosity along flow path
tt	134.2 d	calculated travel time from z1 to z2
Linear Velocity	11.18 ft/d	calculated
C1	1	unit concentration of injectate at top of injection zone
t-half	12.3 yr	tritium half-life
C2	0.980	calculated fraction of unit tritium concentration at discharge to USDW aquifer after decay
Discharge Area	0.98 ft^2	assumed failed well (leakage) area through MCU
Discharge Rate	0.67 ft^2/d (54 gal/d)	volumetric discharge rate of injectate through failed well
UFA Mixing Width	32.81 ft	width of UFA over which MCU discharge is mixed
UFA Discharge	4.97 ft^3/d	horizontal volumetric discharge over depth of UFA based on minimum UFA transmissivity and gradient
Mixing Fraction	0.010	assumed fraction of UFA over which MCU discharge is mixed
Dilution Factor	0.931	MCU discharge/(MCU discharge + Mixing Fraction*UFA discharge)

Note: flux calculated based on Post et al. (2007-TN4145)
(a) FSAR Fig. 2.4.12-245
(b) FSAR Fig. 2.4.12-246
(c) minimum FSAR value assumed to be freshwater density = 62.2 lb_m/ft^3
(d) 10,000 mg/L TDS @ 20°C
(e) Starr et al. (2001-TN1251), Injection Zone High Value
(f) Starr et al. (2001-TN1251), Upper Monitoring Low Value (wells being purged were not considered)
(g) Approximate maximum MCU Property Estimate
(h) Minimum value from Reese (1994-TN1439)

Source: FPL 2014-TN4069 unless otherwise noted.

G.4 SAMDA Sensitivity Evaluation and Supporting Documentation

G.4.1 Introduction

FPL performed a SAMDA evaluation and determined that none of the severe accident design alternatives (SAMDAs) can be justified to further reduce the risk of severe accidents. NRC's review of the FPL submittal is detailed in Section 5.11.3. The SAMDA evaluation by FPL and the confirmatory evaluation by NRC identified the self-actuating containment isolation valves design alternative as the only design alternative with a value comparable to the maximum attainable benefit for the Turkey Point site. The results of the FPL analysis indicate that the maximum attainable benefit if the total risk for the AP1000 at the Turkey Point site were reduced to zero would have a value of about $55,513. The cost of implementing the self-actuating containment isolation valves design alternative is estimated to be $33,000. Thus, this SAMDA would be potentially cost-beneficial. To evaluate the maximum benefit of implementing the self-actuating containment isolation for the risk that this SAMDA would actually affect the Containment Isolation severe accident release category of Table 5-18 would be eliminated by this SAMDA and its contribution would be added to the Intact Containment release category. This would result in a benefit associated with this SAMDA of approximately $994. As was

APPENDIX I

THE EFFECT OF CLIMATE CHANGE ON THE EVALUATION OF ENVIRONMENTAL IMPACTS

The review team has determined that it is reasonably foreseeable that climate change may substantially alter the affected environment described in Chapter 2 of this environmental impact statement (EIS). Climate change is a global phenomenon that the construction and operation of the proposed two-unit plant will not appreciably alter. However, climate change will provide a new environment that the operation of the proposed units will affect.

The objective of this appendix is to document the review team's consideration of the potential changes in impacts that may occur as a result of the new future environment. This appendix is not intended to be a comprehensive climate change assessment for the affected region. It documents the review team's qualitative determination of the likely changes in the impacts described in Chapter 5, if the environment is altered in a manner consistent with the predictions in current climate change literature.

The Nuclear Regulatory Commission staff documents the review of the safety of the plant in the Safety Evaluation Report (SER) expected to be published in November 2016 (NRC 2016-TN4619). If the NRC grants the FPL COL application, the staff will inspect and otherwise moniter plant construction and operation. This safety oversight process includes collection and analysis of information regarding changes in the severity or frequency of natural hazards, such as flooding from storm surge and sea level rise, as discussed in SECY-15-0137 (NRC 2015-TN4731). When warranted, the NRC can request licensee study and analysis of changing natural hazards, and can impose additional design or operation requirements to address those changing hazards.

In this appendix, the review team assessed the potential effects of climate change on its evaluation of the environmental impacts of the proposed action. The results of this assessment are presented below in three sections: (1) description of the assessment process, (2) potential climate change impacts in the region, and (3) assessment summary. The appendix also discusses the USACE's consideration of climate change in the context of the USACE Public Interest Review.

I.1 Description of the Assessment Process

As part of its National Environmental Policy Act (42 U.S.C. 4321 et seq.) (TN661) review, the U.S. Nuclear Regulatory Commission (NRC) staff analyzes greenhouse gas emissions and the potential effects of climate change for all resource areas in all new reactor licensing proceedings. In guidance dated August 1, 2016 on greenhouse gas emissions and climate change, the Council on Environmental Quality (CEQ) states "action agencies need not undertake new research or analysis of potential climate change impacts in the proposed action area, but may instead summarize and incorporate by reference the relevant scientific literature."

In this regard, this EIS incorporates by reference the U.S. Global Change Research Program report (GCRP 2014-TN3472; CEQ 2016-TN4732)."

In the first step of the NRC staff's process a master table was created identifying plausible nexuses between nuclear power station resource area issues related to operation and likely climate change impacts as identified in the most recent climate change impacts report issued by the GCRP (2014-TN3472). The interagency GCRP was established under the Global Change Research Act of 1990 (P.L. 101-606) (15 U.S.C. § 2921 et seq.) (TN3330) "to understand, assess, predict, and respond to human-induced and natural processes of global change" and is the authoritative U.S. government source on likely climate change impacts in the United States. The master table was used to develop a list of questions for each resource area to assist the NRC staff in addressing whether GCRP-identified climate change impacts were likely to increase, decrease, or leave unchanged the assessed impact of a proposed facility on the environment, or to identify areas where scientific uncertainty precludes a definitive assessment. The comprehensive master table and question list can be found in the NRC's Agencywide Documents Access and Management System (ADAMS), which is accessible from the NRC website at www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room) under the following accession number ML5026A470 (NRC 2014-TN4149). A table, termed the site-specific resource table, and list of questions specific to the proposed site of Turkey Point Units 6 and 7 were then generated by removing non-relevant GCRP climate impacts and NRC resource area issues, and by using specific Southeast regional predictions identified by the GCRP. For example, the review team determined GCRP-identified direct impacts related to declining ice volume and extent were not relevant to the Turkey Point environment. The review team used the site-specific resource table and question list (NRC 2014-TN4150) in its assessment of the effects of climate change on relevant resource areas given in Section I.3. A combined construction permit and operating license (COL) is valid for 40 years (10 CFR 52.103) (TN251). In conducting its assessment, the NRC staff noted that if COLs are granted to the proposed facilities, baseline changes are more likely to be noticeable during operation (Chapter 5) than during preconstruction and construction (Chapter 4). The review team's efforts thus focused on assessing the potential effects of climate change on the resource area impact levels assigned in Chapter 5. While general scientific consensus exists that climate change is occurring and will continue to occur for the foreseeable future, significant uncertainty remains about the magnitude of the changes for specific regions and the precise magnitude and form of the impacts on the environment from climate change. The review team acknowledges this situation, explicitly noting in this appendix where uncertainty in future climate predictions and uncertainty in impacts may make it impossible at this time to conclude qualitatively the influence of climate change on a specific resource area or issue. The review team also acknowledges that the Southeast Florida Regional Climate Change Compact, which includes Miami-Dade County, has established a Regional Climate Action Plan that discusses goals to reduce greenhouse gas emissions and adapt to regional and local impacts of a changing climate. Some of the climate change impacts discussed in this appendix could be further reduced with the efforts of this Regional Compact.

I.2 Potential Climate Change Impacts in the Region

Climate change is a subject of national and international interest. The recent compilation of the state of knowledge in this area—GCRP's climate change impacts report (GCRP 2014-

TN3472)—has been considered in the preparation of this EIS. Most GCRP projections are expressed as a change expected for the later part of the 21st century (2071−2099) relative to average conditions existing in the later part of the 20th century (1970−1999). Projected changes are also dependent on future emissions of heat-trapping gases. The GCRP's climate change impacts report includes projections for wide-ranging scenarios where such emissions are rapidly reduced and where they continue to increase.

Florida Power & Light Company (FPL) has indicated that, if the COLs are granted, it expects to initiate commercial operations in the second quarter of 2027 and second quarter of 2028 for Units 6 and 7, respectively (FPL 2015-TN4502). The Atomic Energy Act (42 U.S.C. § 2011 et seq.) (TN663) and NRC regulations (10 CFR 52.103) (TN251) limit commercial power reactor licenses to an initial 40 years. If granted, under FPL's proposed schedule the COLs would be valid until 2067 and 2068. The NRC staff considers use of GCRP impacts report projections for the 2071−2099 period under a continued increasing emissions scenario to be a conservative proxy for likely future conditions encompassing the licensing action, and for assessing the effects of climate change on the resource area impact levels presented in this EIS. Unless otherwise stated, projected climate changes discussed in this section are taken from the impacts report (GCRP 2014-TN3472) and refer to changes for the 2071−2099 period relative to the 1970−1999 period under an increasing emissions scenario.

Projected changes in the climate for southeastern Florida include an increase in average surface air temperature of 5°F to 6°F. The number of days with maximum temperatures above 95°F is expected to increase, rising by 50 or more days per year for the 2041−2070 period relative to 1971−2000. The hottest and coldest days expected in a 20-year period at the end of this century (2081−2100) are both projected to be 6°F to 7°F warmer than those experienced at the turn of the last century (1986−2005); in other words, both the hottest and the coldest days will be warmer. Southeastern Florida is projected to experience no days with temperatures below 32°F during the 2070−2099 period; currently, the low-temperature extreme for the proposed Turkey Point site is 25°F (Section 2.9.1.2). Projected precipitation changes in southeastern Florida vary seasonally, increasing by 0 percent−10 percent in winter, decreasing by 0 percent−10 percent in spring, decreasing by 20 percent−30 percent in summer, and increasing by 10 percent−20 percent in fall. Extreme heavy precipitation events are expected to increase in both frequency and intensity; an event that now occurs once in 20 years is projected to occur 2 to 3 times as often by the end of the century. Heavy precipitation events are expected to have a 20 percent increase in the amount of precipitation falling. The climate change impacts report indicates that the number of tropical storms occurring around the globe will decrease, but those that occur will be stronger in force, yielding more Category 4 and 5 storms. Rainfall rates associated with tropical storms are expected to be greater, "…with projected increases of about 20 percent averaged near the center of hurricanes" (GCRP 2014-TN3472).

Sea level is projected to rise 1 to 4 ft globally by 2100 (GCRP 2014-TN3472). However, the review team acknowledges that, at the extreme high end, global sea level is predicted to rise by 8.2 ft by 2100 relative to 2000. Should this extreme high range of sea level rise occur, much of South Florida would be uninhabitable and millions of people would likely be displaced. Sea level rise, however, occurs gradually, so that adaptation is possible. As explained in the impacts report, the amount of sea-level rise experienced in any one location "depends on whether and how much the local land is sinking…or rising, and changes in offshore currents." In its report, the GCRP rates the vulnerability of the Turkey Point area to sea-level rise as "high" to "very high," and notes an "imminent threat of increased inland flooding during heavy rain events in low-lying coastal areas such as southeastern Florida, where just inches of sea level rise will impair the capacity of stormwater drainage systems to empty into the ocean." Sea-level rise also is expected to "…accelerate saltwater intrusion into freshwater supplies from rivers, streams, and groundwater sources near the coast" and agricultural areas around Miami-Dade County "…are at risk of increased inundation and future loss of cropland with a projected loss of 37,500 acres in Florida with a 27-inch sea level rise." Water demand in southeastern Florida is projected to increase by more than 50 percent by 2060, relative to 2005, based on combined changes in population, socioeconomic conditions, and climate. The GCRP cites the Southeast Florida Regional Compact as an "excellent example" of regional cooperative efforts among local, state, and federal agencies to develop "a comprehensive action plan" to adapt to impacts from climate change and sea-level rise.

The NRC staff also considered localized sea level rise associated with changes in regional ocean currents (Ezer et al. 2013-TN4734; Park and Sweet 2015-TN4733). The NRC staff determined that these localized changes were adequately bounded by the 1 to 4 ft sea level rise projected in the GCRP report.

The Southeast region currently contains "…existing power plant capacity to produce 32 percent of the nation's electricity," but also currently consumes 27 percent of the nation's total capacity, more than any other GCRP-defined region. Higher temperatures and increased use of air conditioning are projected to increase regional energy demand, "potentially stress[ing] electricity generating capacity, distribution infrastructure, and energy costs" (GCRP 2014-TN3472).

Other climate change impacts in the Southeast region identified in the GCRP report and relevant to the Turkey Point area include ecosystem exposure to risks from sea-level rise, particularly in tidal marshes, swamps, and wetlands; compromised protection of coastal lands and people against storm surge due to tidal wetland loss; effects on fisheries and fishery habitats due to wetland loss; spread of non-native plants; decreased crop production and livestock yield; increased formation of allergens and air pollutants, including ozone; and increases in harmful algal blooms and other surface-waterborne disease-causing agents. In addition, the GCRP indicates the potential for ocean warming leading to changes in local species composition, growth rates, spawning seasons, and/or migratory patterns; increased wildfire frequency, intensity, and size; effects on vector-borne and zoonotic (animal to human) disease transmission; increased insurance costs or unavailability of insurance coverage due to increased flooding incidents; stresses on society and infrastructure due to movement of people from vulnerable areas; effects of changes in energy costs on lower income households, the elderly, native tribes, and other vulnerable communities; and damage to transportation infrastructure.

I.3 Assessment Summary

This section summarizes the review team's assessment of the effects of climate change on relevant resource areas using the process outlined in Section I.1.

I.3.1 Land Use

I.3.1.1 Land-Use Summary

Climatological changes are not likely to influence, or lead to, any plant operational impacts on local/regional land-use classifications or economic development plans. Climate change could lead to changes in the distribution of land use in Miami-Dade County and sea-level rise could lead to the loss of some inhabitable land in the county. However, once the operational workforce is housed in the initial years of operation, operation of a reactor is not expected to alter land use. Therefore, there is little potential for interaction between land-use changes resulting from climate change and land-use changes caused by later operational years of the reactor.

I.3.1.2 Land-Use Conclusion

Climatological changes are not expected to affect the land-use operational impact level assigned in Chapter 5.

I.3.2 Hydrology

I.3.2.1 Summary

Climatological changes are not expected to affect the anticipated hydrologic alterations resulting from station operation, or influence (or lead to) plant operations impacts on other water uses and users. Sea-level rise will result in greater depth of Biscayne Bay near the Turkey Point site. Because of the current very shallow conditions of Biscayne Bay in this vicinity even a modest increase in sea level may help to improve circulation (reducing the hypersalinity of water entering the radial collector well system). Circulation is also controlled by flow conditions away from the site. The review team presumed that the cooling canals' water-surface elevation would likely also rise in response to the rise in sea level. This rise would increase the volume of water in the canals, but it is not expected to appreciably change the gradient between Biscayne Bay and the cooling canals. Therefore, no change in the interface between the canals and the Bay is expected.

Sea-level rise will also push the freshwater–seawater interface further inland. This will put further stresses on freshwater resources inland. However, because the proposed Units 6 and 7 would use reclaimed wastewater for most of its water needs, this would not alter the impact of the plant. Groundwater modeling analyses performed by the NRC staff explicitly considered the changes in impacts of operation of the radial collector wells that would occur with reduced inland recharge (e.g. drought) and increased sea level (see Appendix G.3). While saltwater intrusion is shown to move farther inland under both of these scenarios, the radial collector wells are shown to not have contributed to the saltwater intrusion.

Sea-level rise combined with more frequent Category 4 and 5 storms will increase the potential for damaging storm surge events at the Turkey Point site (Little et al. 2015-TN4729). The final SER discusses the safety of the proposed plants in regard to natural flooding hazards, including hazards from extreme hurricanes combined with other factors such as sea level rise. An extreme natural flood at the site, however, could damage features at the site, including the IWF for the existing units, piles of spoils from muck removal for the construction of the proposed units, and non-safety related structures built for the proposed units. While storm surge damage to these features would result in the release of sediment and nutrients to Biscayne Bay, such damage would not be localized to the Turkey Point site. The contribution of the Turkey Point site to the release of sediment and nutrients to Biscayne Bay as result of an extreme flood would likely be a small fraction of the total sediment and nutrient load that would enter the local waterways.

As discussed in Section I.2, precipitation amounts in South Florida are projected to shift in different directions in different seasons. Even if total precipitation increases, if the majority of this increase is in response to intense storms it would not result in a proportional increase in recharge to groundwater. The increase in temperature may also increase evapotranspiration, thereby further reducing recharge. The review team determined that overall recharge to the Biscayne Bay aquifer may be reduced as a result of climate change. However, because the proposed plant would use reclaimed wastewater for most of its water needs, this would not alter the plant's impact on the environment.

The review team could not determine whether an increase in temperature or changes in precipitation patterns would result in any change in the supply of wastewater for the plant's cooling system. A substantial increase in sea level rise, however, could impact the wastewater treatment plant that provides the primary source of cooling water for proposed Units 6 and 7. Given the abundance of wastewater in this region, the review team determined that a sufficient supply of wastewater would remain available regionally. In the event of substantial sea level rise, Miami Dade County may adapt some of its wastewater treatment infrastructure. Given the critical public health role of these facilities, the review team determined that such adaptations are reasonably foreseeable.

I.3.2.2 Conclusion

The review team identified no shift in the Chapter 5-assigned impacts on water use and water quality caused by the operation of the proposed plant due to a reasonably foreseeable alteration in the environmental baseline associated with climate change.

I.3.3 Terrestrial & Wetland Ecology

I.3.3.1 Summary

Climatological changes could affect the impact of plant operations from facility and landscape maintenance, noise, and traffic on terrestrial habitats and wildlife. In particular, climate change could increase stress on terrestrial habitats, especially the freshwater and brackish water wetlands comprising the Everglades, the mangrove wetlands adjoining Biscayne Bay, and the tree islands and remnant patches of pine rocklands that dot the surrounding landscape. Climate change could result in longer periods between precipitation events, drier conditions during some seasons, and more frequent wildfires that could facilitate introduction of new diseases and pests. Sea-level rise could stress mangrove forests due to inundation and could stress surviving wetland vegetation by introducing brackish water farther inland, while the expected tendency to armor fastlands could prevent concurrent establishment of more inland mangrove forests and other coastal wetlands. Climate change would place additional stress on the same habitats and wildlife affected by the operational impacts discussed in Section 5.3.1. Particularly noteworthy is that the stresses on wetlands and other terrestrial habitats caused by climate change could result in greater introduction of exotic species such as Melaleuca, Australian pine, and the Burmese python.

The expected climatological changes could exacerbate the effects of plant operations (discussed in Section 5.3.1) on terrestrial habitats, wetlands, and species. In particular, climate change could lead to drier conditions due to longer periods between precipitation events and wildfires. Climate change could reduce the extent of mangrove forests primarily due to coastal inundation and sawgrass in the Everglades primarily due to alteration of hydroperiod, stressing vegetation and wildlife. Increased introduction of exotic species could further reduce the ecological and hydrological function of wetlands and reduce the suitability of various upland and wetland habitats to threatened, endangered, and rare species.

The expected climatological changes could worsen the minor effects of plant and transmission line operations on birds, bats, and other wildlife due to collisions, electrocution, or electromagnetic radiation effects (discussed in Section 5.3.1). Climate change could substantially alter the hydroperiod of habitats traversed by the proposed corridors for the two transmission lines, including the eastern Everglades and remnant pine rockland patches. These changes could stress wildlife dependent on the affected habitats, including birds, bats, and other wildlife. Even though the effects on wildlife from collisions, electrocution, and electromagnetic radiation are typically minor (see Section 5.3.1), the stresses could be exacerbated when combined with the effects of climate change.

Although climate change could potentially interact synergistically with plant operations to raise impact levels on terrestrial wildlife from plant operations and influence the impact of the proposed units on terrestrial resources and wetlands, the ability to coordinate with other agencies should not be noticeably impeded. The importance of close coordination would, however, be greater.

The expected climatological changes could affect the overall impact of plant operations on regional standing stocks of important terrestrial species, including plant impacts on species' tolerance of environmental changes and their natural survival rates. The increased potential for substantial adverse effects on the sensitive wetland and upland habitats surrounding the Turkey Point site and proposed new offsite corridors would concurrently place increased stresses on species using those habitats, including important species. The increased stresses caused by climate change could reduce the tolerance of some important species to collisions, noise, and other plant operational impacts. Furthermore, many of the identified important species are species whose populations have already been severely lowered by recent decades of drainage and development, and thus are less capable of recovery from new stresses.

The stresses placed on terrestrial habitats by climate change could lead to a greater potential for introduction of disease organisms and invasive species. Climate change could stress those habitats by decreasing the hydroperiod and by inducing the introduction of exotic species adapted to warmer climates and seasonally drier habitats. The subject habitats have already been stressed by a history of introduction of numerous invasive species. Additional stresses to native vegetation can be expected to encourage the further establishment of invasive species.

I.3.3.2 Conclusion

Climate change could place multiple new stresses on wetlands and other terrestrial habitats, especially the hydrologically sensitive Everglades and Everglades National Park, the extensive mangrove forests bordering Biscayne Bay, including those within Biscayne National Park, and other unique ecological communities such as pine rocklands. Climate change would place additional stress on the same habitats and wildlife stressed by plant operations and could cause an increase in the impacts on terrestrial resources discussed in Section 5.3.1.

I.3.4 Aquatic Ecology

I.3.4.1 Summary

Climatological changes would have minimal influence on the impact of the operation of proposed Units 6 and 7 on aquatic resources using either reclaimed water or radial collector wells. A change in sea level would not influence the availability of reclaimed water, so an increase of cooling-water withdrawal by the radial wells is not expected. Sea-level rise will increase the depth of Biscayne Bay but it is not expected to affect the operation of the radial wells. Entrainment, entrapment, and impingement are highly unlikely due to the use of reclaimed water and RCW operation, and there is no evidence operation would directly affect aquatic resources. There is no evidence that proposed Units 6 and 7 would affect species tolerance or natural survival rates, or contribute to an increase in invasive or introduced species. Given the proposed cooling-system configurations, influence on the water quality of nearby receiving water would be negligible. Changes in baseline conditions due to climate change are not expected to alter this result. Climate change is not expected to noticeably impede the ability of agencies to coordinate on the protection of aquatic species. The importance of close coordination would, however, be greater.

I.3.4.2 Conclusion

The review team identified no shift in the Chapter 5-assigned impacts on aquatic ecology caused by the operation of the proposed plant due to a reasonably foreseeable alteration of baseline conditions associated with climate change.

I.3.5 Socioeconomics

As discussed in Section 5.4 and summarized in Section 10.2.2, within the area of socioeconomics the categories of physical impacts, demographic impacts, economic impacts, and impacts on infrastructure and community services are assessed separately, and individual category impact levels are assigned. These same categories are discussed here.

I.3.5.1 Summary

The review team determined that all of the expected physical impacts during operations (noise, air quality, buildings, roads, waterways, and aesthetics) would be SMALL and would warrant no mitigation. During the life of the proposed license the review team expects physical impacts on the listed categories would not be exacerbated by the effects of climate change and would remain at negligible levels.

The impacts on the demographic makeup of the area surrounding the proposed site would be SMALL and would not warrant mitigation. If the speculated climate change impacts were to occur during the life of the proposed license, the review team believes the demographic impact would be an out-migration of residents to other areas with higher elevations. Consequently, the operations-related impacts on the demographic makeup of the area would be reduced even further.

All economic impacts from operations of the proposed project would be beneficial and SMALL for Miami-Dade County, Homestead, and Florida City. In the event of climate change-induced sea-level rise, which is likely to occur gradually, the NRC requires licensees of nuclear power plants to implement corrective actions to mitigate conditions adverse to safety. The applicant would need to take measures to mitigate the effects of global climate change such that the proposed nuclear power plants would continue to be operated safely in accordance with 10 CFR Part 50 (TN249). Therefore, the review team anticipates the economic impacts of operations of the proposed project would continue unchanged.

There are four major subsections in the review team's assessment of the operations-related impacts on infrastructure and community services from the proposed project: traffic, recreation, housing, and public services.

- **Traffic**. The review team determined that the operations-related impacts of traffic would be moderate. While the long-term effects of global climate change would have a deleterious impact on the current level of infrastructure in the area, the review team believes it is not unreasonable to expect decision makers in the area to incrementally adapt to the climate change effects (e.g., sea-level rise) by incorporating mitigating measures that would prevent the deterioration of infrastructure services (e.g., raising the elevation of roads). Such adaptive measures would impose significant costs on local communities, the funds for which would either have to come from increased revenues (taxes and tolls) or be diverted from other expenses (maintenance, personnel, services). Consequently, the review team expects that if the physical changes predicted by the GCRP report (GCRP 2014-TN3472) were to occur, the traffic-related impacts on the local communities would increase.
- **Recreation**. The primary receptors of recreational impacts due to operations are accessibility and aesthetics. The review team expects that, like traffic, the long-term effects of climate change would significantly change the aesthetic appeal of local recreation areas and the public's access to Biscayne Bay and the Everglades. However, the NRC portion of the total impact would remain unchanged.
- **Housing**. The review team expects that any physical change in the environment from global climate change would occur at a rate slow enough that home owners in low-lying areas could either adapt their homes to the new conditions or to move out of the area. Consequently, the cumulative impact of global climate change on housing in the economic impact area would decline as the local population migrated away from the 50 mi region.

- **Public Services**. The review team expects that any physical change in the environment from global climate change would occur at a rate slow enough that local governments could adapt to whatever negative impacts may arise. Consequently, the review team determined the global climate change impacts on community services would decline as the population migrated away from the 50 mi region.

I.3.5.2 Conclusion

As indicated in Chapter 5, the review team identified no significant shifts in socioeconomic impacts of operational impacts as a result of possible climatological changes in the environmental baseline. Potential impacts on socioeconomics including infrastructure and community services as a result of climate change would continue to be addressed through regional and local governmental strategic adaptive plans.

I.3.6 Environmental Justice

I.3.6.1 Summary

Climate change could present challenges to minority and low-income communities, which the GCRP climate change impacts report refers to as "socially vulnerable populations," within the demographic region of the proposed project. The challenges include coping with climate change effects (e.g., sea-level rise), the capacity to adapt, and the ability to relocate. The review team believes it is not unreasonable to expect decision makers in the area to incrementally adapt to the climate change effects by implementing strategic adaptation plans and mitigating measures that would inform and assist minority and low-income communities. Therefore, the conclusions in Section 5.1.1 regarding environmental justice would remain unchanged.

I.3.6.2 Conclusion

Overall, the operational impact levels assigned to environmental justice in Chapter 5 did not change as a result of possible climatological changes in the environmental baseline. Potential impacts on environmental justice communities as a result of climate change would continue to be addressed through regional and local governmental strategic adaptive plans.

I.3.7 Historic and Cultural Resources

I.3.7.1 Summary

There are no known onsite historic and cultural resources at the Turkey Point site; therefore, there would be no shift in the impacts on historic and cultural resources caused by the operation and maintenance of the proposed plant due to a reasonably foreseeable alteration in the environmental baseline associated with climate change. It is not known whether the change in the environmental baseline would cause a shift in impacts of offsite facilities (e.g., transmission lines).

I.3.7.2 Conclusion

As previously discussed, the climatological changes would not affect the historic and cultural impact level assigned in Chapter 5 because of the lack of resources at the Turkey Point site. It is not known whether the change in the environmental baseline would affect offsite resources.

I.3.8 Meteorology

I.3.8.1 Summary

The expected climatological changes would largely be unlikely to affect cooling-system impacts from the operating plant on local weather. Projected temperature increases due to climate change may lead to an increase in fogging from the cooling tower. Changes in severe weather intensity or length of dry spells would be unlikely to change the current parameters.

I.3.8.2 Conclusion

Operational impacts from the cooling system on local weather are discussed in Section 5.7.2 and should not change as a result of reasonably foreseeable climate changes.

I.3.9 Air Quality

I.3.9.1 Summary

Climatological changes may affect the sources, types, and estimates of annual air emissions from the operating plant and transmission lines. For example, changes in climate such as sea-level rise and increased extreme weather events may lead to an increase in air emissions from emergency equipment, if additional emergency backup equipment is needed for the proposed plants and if testing of that equipment increases. Because of expected increases in temperature over the period of operation, the health impacts of operational air emissions may increase. In a higher temperature environment, the formation of ozone due to emissions of nitrogen oxides (NO_x) from the diesel generators and other equipment is likely to increase, thereby leading to an increase in health impacts.

I.3.9.2 Conclusion

Operational air-quality impacts are discussed in Section 5.7.1 and should not change as a result of reasonably foreseeable climate changes. It is unclear whether additional emergency equipment would actually be needed in a changing climate, or whether testing of that equipment would increase, causing an increase in air emissions. Any additional equipment would be subject to Clean Air Act (42 U.S.C. § 7401 et seq. (TN1141) Title V permitting requirements. Estimates of air emissions are likely to remain the same, with a possible increase in health impacts due to increased ozone formation from emergency equipment NO_x emissions in a higher temperature environment.

I.3.10 Nonradiological Health

I.3.10.1 Summary

It is not known how changes in climate will affect the presence of etiological agents associated with plant operations (receiving waters and cooling-tower operations). However, it is reasonable to expect that currently existing laws and regulations protecting workers and members of the public would continue, or would be adjusted as necessary, to be as protective as they are under current climate conditions.

Climatological changes are not likely to have an effect on noise produced by operating plants; therefore, there would be no change in the health impacts from noise discussed in Section 5.8.2.

It is not likely that climatological changes would affect potential health impacts from electromagnetic fields (EMFs) associated with plant operations because regulations protecting workers and members of the public from EMFs would likely be adjusted to avoid impacts.

It is not likely that climatological changes would affect occupational health risks for operational plants because regulations protecting workers would be adjusted to avoid impacts on workers.

As discussed in Section I.3.5.1, while the long-term effects of global climate change would have a deleterious impact on the current level of infrastructure in the area, the review team believes it is not unreasonable to expect decision makers in the area would incrementally adapt to the climate change effects (e.g., sea-level rise) by incorporating mitigating measures that would prevent the deterioration of infrastructure services (e.g., raising the elevation of roads, adjusting speed limits). The review team expects that if the physical changes predicted by the GCRP were to occur, such adaptive measures would limit potential health impacts from traffic-related accidents.

I.3.10.2 Conclusion

Overall, the expected climatological changes would not change the nonradiological health resource operational impact level assigned in Chapter 5. Potential impacts from noise, etiological agents, exposure to EMFs, and occupational injuries are and would continue to be regulated to be protective of human health. Although there is some uncertainty surrounding predicted climatological changes, it is likely that regulations governing occupational and public health would be adjusted accordingly if needed.

I.3.11 Radiological Impacts

I.3.11.1 Summary

The review team determined that the expected climatological changes would affect the possibility of exposure to radiation from the operating facility as follows:

- Existing low population exposures of humans from proposed Units 6 and 7 would remain low because the level of effluent releases and regulatory requirements should not significantly change over the time of the license.

- Existing low non-human biota exposures from proposed Units 6 and 7 should not change because the level of effluent releases and regulatory requirements should not significantly change over the time of the license.
- The level of effluent releases, regulatory requirements (including those for occupational doses), and existing low exposures should not significantly change over the time of the license.
- The level of the expected normal radioactive gaseous effluent releases would remain the same. Thus, monitoring activity should remain the same with the exception that the monitoring locations could change because of changes in the physical land and population distribution around the site. Normal radioactive liquid effluent releases should remain unchanged due to the use of deep-well injection.

I.3.11.2 Conclusion

The NRC staff identified no shift in the radiological impacts level caused by the operation of the proposed Units 6 and 7 due to reasonably foreseeable environmental alterations associated with climate change, because the level of effluent releases, regulatory requirements, and existing low population exposures should not significantly change over the time of the license.

I.3.12 Nonradioactive Waste

I.3.12.1 Summary

Sea-level rise and changes in land-use decisions may lead to changes in disposal options for nonradioactive waste and mixed wastes. However, solid, liquid, gaseous, hazardous, and mixed wastes generated during operation of the proposed Turkey Point Units 6 and 7 would still have to be handled, transported, stored, and disposed of according to County, State, and Federal regulations.

I.3.12.2 Conclusion

Because nonradioactive and mixed wastes would still be subject to applicable Federal, State, and local requirements, climatological changes are unlikely to influence the SMALL impact determination discussed in Section 5.10.4.

I.3.13 Accidents

I.3.13.1 Summary

Climatological changes are expected to affect the site-specific, 50th percentile atmospheric dilution factor (i.e., χ/Q) used to evaluate dose consequences from postulated design basis accidents (DBAs). The χ/Q around the site is dependent on local meteorological conditions (wind speed, direction and stability class). The expected variations for these parameters as a result of climate change may increase, likely leading to less stability, which would likely increase dispersion and decrease the corresponding radiological effects. However, the predominant wind direction could change such that higher χ/Qs could shift along the site boundary, low-population zone, and beyond to areas with higher population density, which would increase the impact. Therefore, the overall impact is unknown. Climatological changes might affect the average environmental risks of severe accidents because of changes in either severe accident probabilities or associated consequences. While the potential severity of storms and other natural phenomena might increase, nuclear power plants must be designed to withstand all creditable natural events at the site of concern.

As discussed in Section I.2, climate change in general and rising sea level are expected to be gradual. If the NRC grants the FPL COL application, the staff will inspect and otherwise moniter plant construction and operation. This safety oversight process includes collection and analysis of information regarding changes in the severity or frequency of natural hazards, such as flooding from storm surge and sea level rise, as discussed in SECY-15-0137 (NRC 2015-TN4731). When warranted, the NRC can request licensee study and analysis of changing natural hazards, and can impose additional design or operation requirements to address those changing hazards. In particular, the NRC can request information from a licensee under 10 CFR 50.54(f), and can determine whether or not a license should be modified based on the information provided in response the request. Such information could include the impact of climate change on plant operation, emergency preparedness, and the availability of nearby structures used for plant operation and safety. If the NRC determines that additional safety enhancements are necessary based on information obtained in accordance with 10 CFR 50.54(f), the NRC can require that such enhancements be implemented in a timely manner to assure adequate protection of the public within the current NRC regulatory process. The NRC staff generally expects that the low core damage frequencies (CDFs) for the AP1000 pressurized water reactor design are unlikely to change appreciably due to climate change. Therefore, even if consequences of severe accidents slightly change as a result of climate change, severe accident risk is likely to remain SMALL because CDFs are maintained low.

The effects of climatological changes on the severe accident mitigation alternative (SAMA) cost-benefit analysis of the proposed facility are uncertain. While the averted costs have components that are based on local land values and the cost of evacuation and cleanup, these are typically not the major contributors to the total averted costs. Rather, the cost of replacement power has a larger effect and it is uncertain whether climate change would have an effect that would change the SAMA cost-benefit analysis. However, because the smallest difference between a cost-beneficial severe accident mitigation design alternative that was not studied further for the AP1000 design at the Turkey Point site (see Section 5.11.3) and the averted cost is approximately $400,000 (7 percent discount rate), it is difficult to see how climate change would affect the probability-weighted consequences from severe accidents in a manner to cause a finding different from SMALL for SAMAs.

I.3.13.2 Conclusion

The impact level assigned in Chapter 5 should remain SMALL for next-generation nuclear power plants like the AP1000 reactor design. The overall risks for severe accidents are significantly lower than the current generation of nuclear power plants and any climate change effect would have to change the risks by at least two orders of magnitude to result in a change in the impact level assigned in Chapter 5.

I.3.14 Transportation of Radiological Materials

I.3.14.1 Summary

The number and type of radioactive material shipments, regulatory requirements, and existing low maximally exposed individual and population exposures and risks from accidents for these types of shipments should not significantly change over the time of the license as a result of climate change. Radiological doses are strong functions of the radiation dose rate emitted from the shipment, exposure distance, and exposure duration. None of these parameters would be directly or disproportionately influenced by the impacts of climate change. Transportation accidents risks are a function of weather conditions. However, climate change may increase dispersion conditions in some areas as a result of more frequent storms and severe weather, but may also reduce dispersion in areas where climate change may result in more mild average conditions. As a result, the changes in transportation impacts potentially caused by climate change are not expected to be significant, but there are substantial uncertainties about impacts on weather conditions in specific areas and demographic changes that could affect transportation impacts in the region of interest.

I.3.14.2 Conclusion

Impact levels are not expected to change as a result of the effects of climate change, but there are significant uncertainties associated with the impacts of climate change on local weather conditions and demographics.

I.3.15 Benefit-Cost

I.3.15.1 Summary

Climatological changes could affect the estimated operational benefits and costs of the proposed facility. Proposed Turkey Point Units 6 and 7 would continue to provide benefits in the form of electricity generation and economic impacts to the region such as tax impacts and other spending. To the extent that summer peak demand load increases, the benefit of a large baseload power station such as Units 6 and 7 could increase.

Operating costs include maintenance costs, fuel costs, and annualized capital costs. Future climate change impacts would not affect the already incurred capital costs. However, to the extent that climate change events require repair or prolonged shutdown of Units 6 and 7, maintenance costs could increase.

I.3.15.2 Conclusion

Although climate change could increase or decrease the benefits and costs of the project, the review team expects the accrued benefits of construction and operation of Units 6 and 7 would still outweigh the associated costs.

I.3.16 U.S. Army Corps of Engineers Public Interest Review

I.3.16.1 Summary

Pursuant to NEPA and the USACE public interest review at 33 CFR 320.4, the USACE considers the effects of climate change and sea level rise on the proposed project in order to determine whether the proposed project is contrary to the public interest. As set forth below, the USACE has determined that the NRC Advanced Safety Evaluation (ASE) dated July 14, 2016, on the Florida Power & Light (FPL) application to the NRC considers the effects of sea level rise on the proposed project (NRC 2016-TN4775).

As background, the NRC determined that the structures, systems, components, and design features of the AP1000 standard design comply with applicable NRC regulations and therefore provide adequate protection to the health and safety of the public. The NRC based its evaluation of the AP1000 design in part on assumed physical and environmental site features, such as maximum flood height compared to plant elevation, used to design the standard plant. The NRC calls these site features assumed for design “site parameters,” and they are specified in the Design Control Document (DCD) for the AP1000 standard design. In order for a company to obtain an NRC license to build and operate an AP1000 plant at an actual site, its application must show that the AP1000 design can handle the actual physical and environmental features of the proposed site, which the NRC calls “site characteristics.” To do this, the applicant compares the actual site characteristics to the site parameters postulated for design. If the site characteristics fall within the site parameters used to design the plant, then the standard AP1000 design protects the plant from the effects of the environment on the plant at that site, as required by NRC regulations. If a site characteristic does not fall within a site parameter, the applicant must provide engineering analysis to justify why the plant is nevertheless acceptable to build and operate on the proposed site.

For the proposed Turkey Point Units 6 and 7 reactors, the FPL application to the NRC included information to demonstrate that the actual Turkey Point site characteristics fall within the site parameters in the AP1000 DCD, except for four site parameters. For these four site parameters, FPL proposed departures from the AP1000 DCD, as allowed under NRC regulations. The four site parameters for which FPL proposed departures are population distribution exclusion area (site), the operating basis wind speed, maximum safety wet-bulb (non-coincident) air temperature value, and maximum normal wet-bulb (non-coincident) air temperature value. The NRC staff evaluation of the application in the ASE for Turkey Point Units 6 and 7 concludes that the applicant (1) justified the four proposed departures from the DCD site parameters and (2) demonstrated that the other characteristics of the Turkey Point site fall within (are bounded by) the site parameters specified in the AP1000 DCD (NRC 2016-TN4775).

In assessing whether the actual site characteristics fall within the postulated site parameters in the DCD, both the application and the NRC ASE consider the effects of sea-level rise. In particular, the NRC staff evaluations in the ASE Sections 2.3.1.4.7, “Climate Change,” 2.4.5.4.4, “Antecedent Water Level,” 2.4.5.4.5, “Analysis of Probable Maximum Storm Surge,” 2.4.5.4.6, “Wave Actions,” 2.4.6.4.3, “Source Generator Characteristics,” 2.4.6.4.5, “Tsunami Water Levels,” and 2.4.9.4.3, “Shoreline Changes” explicitly consider the effects of sea-level rise in connection with the NRC staff evaluation of the Turkey Point site characteristics. While the NRC staff did not explicitly consider sea level rise in its evaluation in ASE Section 2.4.12.4.12, “Site Characteristics for Subsurface Hydrostatic Loading,” the NRC staff determined that the actual groundwater level was at least twenty (20) feet below the maximum allowable groundwater level specified in the DCD for the AP1000 design, and that no further evaluation was warranted (NRC 2016-TN4775).

I.3.16.2 Conclusion

In view of the foregoing, the USACE has determined that the NRC staff has evaluated the effects of sea level rise on the proposed Turkey Point Units 6 and 7 in the context of its flooding evaluations in the ASE.

I.4 References

10 CFR Part 50. *Code of Federal Regulations*, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities." Washington, D.C. TN249.

10 CFR Part 52. *Code of Federal Regulations*, Title 10, *Energy*, Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." Washington, D.C. TN251.

15 U.S.C. § 2921 et seq. Global Change Research Act of 1990. TN3330.

42 U.S.C. § 2011 et seq. Atomic Energy Act of 1954. TN663.

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ORAL ARGUMENT NOT YET SCHEDULED

No. 20-1026

IN THE UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT

FRIENDS OF THE EARTH, NATURAL RESOURCES DEFENSE COUNCIL, INC., AND MIAMI WATERKEEPER,
Petitioners,

v.

UNITED STATES NUCLEAR REGULATORY COMMISSION AND UNITED STATES OF AMERICA,
Respondents.

Petition for Review of a Final Order of the
United States Nuclear Regulatory Commission

DEFERRED JOINT APPENDIX
VOLUME 3 of 4

JA00916 TO JA01445

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January 2018

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1.0 INTRODUCTION

1.1 Purpose of and Need for Action

The U.S. Nuclear Regulatory Commission (NRC) licenses the operation of domestic nuclear power plants in accordance with the Atomic Energy Act (AEA) of 1954, as amended, and NRC implementing regulations. Florida Power & Light Company (FPL) operates Turkey Point Nuclear Plant Units 3 and 4 (PTN) pursuant to NRC operating licenses (OLs) DPR-31 and DPR-41, respectively. Based on a license renewal application (LRA) submitted in 2000, the NRC issued renewed OLs in June of 2002, providing authorization to operate for an additional 20 years beyond the original 40-year licensed operating period. Currently, the renewed Unit 3 OL expires at midnight on July 19, 2032, and the renewed Unit 4 OL expires at midnight on April 10, 2033. PTN is located on Biscayne Bay in Miami-Dade County, Florida.

FPL has prepared this environmental report (ER) in conjunction with its application to the NRC for a subsequent renewal of the PTN OLs, as provided by the following NRC regulations:

- Title 10, Energy, Code of Federal Regulations (CFR), Part 54, Requirements for Renewal of Operating Licenses for Nuclear Power Plants, Section 54.23, Contents of Application—Environmental Information [10 CFR 54.23].

- Title 10, Energy, CFR, Part 51, Environmental Protection Requirements for Domestic Licensing and Related Regulatory Functions, Section 51.53, Postconstruction Environmental Reports, Subsection 51.53(c), Operating License Renewal Stage [10 CFR 51.53(c)].

The NRC has defined the purpose and need for the proposed action, renewal of the OLs for nuclear power plants such as PTN, as follows (NRC 2013a):

> The purpose and need for the proposed action (issuance of a renewed license) is to provide an option that allows for baseload power generation capability beyond the term of the current nuclear power plant operating license to meet future system generating needs. Such needs may be determined by other energy-planning decision-makers, such as State, utility, and, where authorized, Federal agencies (other than the NRC). Unless there are findings in the safety review required by the AEA or the National Environmental Policy Act (NEPA) environmental review that would lead the NRC to reject a LRA, the NRC does not have a role in the energy-planning decisions of whether a particular nuclear power plant should continue to operate.

The renewed OLs would allow an additional 20 years of operation for the PTN units beyond their current licensed operating periods. The subsequent renewed license for PTN Unit 3 would expire at midnight on July 19, 2052, and the subsequent renewed license for PTN Unit 4 would expire at midnight on April 10, 2053.

FPL has prepared Table 1.0-1 to verify conformance with regulatory requirements. Table 1.0-1 indicates the sections in the PTN subsequent license renewal (SLR) ER that respond to each requirement of 10 CFR 51.53(c).

Table 1.0-1
Environmental Report Responses to License Renewal Environmental Regulatory Requirements (Sheet 1 of 4)

Description	Requirement	ER Section(s)
Environmental Report—General Requirements [10 CFR 51.45]		
Description of the proposed action	10 CFR 51.45(b)	2.1
Statement of the purposes of the proposed action	10 CFR 51.45(b)	1.0
Description of the environment affected	10 CFR 51.45(b)	3.0
Impact of the proposed action on the environment	10 CFR 51.45(b)(1)	4.0
Adverse environmental effects which cannot be avoided should the proposal be implemented	10 CFR 51.45(b)(2)	6.3
Alternatives to the proposed action	10 CFR 51.45(b)(3)	2.6, 7.0, and 8.0
Relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity	10 CFR 51.45(b)(4)	6.5
Irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented	10 CFR 51.45(b)(5)	6.4
Analysis that considers and balances the environmental effects of the proposed action, the environmental impacts of alternatives to the proposed action, and alternatives available for reducing or avoiding adverse environmental effects	10 CFR 51.45(c)	2.6, 4.0, 7.0, and 8.0
Federal permits, licenses, approvals, and other entitlements which must be obtained in connection with the proposed action and description of the status of compliance with these requirements	10 CFR 51.45(d)	9.0
Status of compliance with applicable environmental quality standards and requirements which have been imposed by federal, state, regional, and local agencies having responsibility for environmental protection, including, but not limited to, applicable zoning and land-use regulations, and thermal and other water pollution limitations or requirements	10 CFR 51.45(d)	9.0

Table 1.0-1
Environmental Report Responses to License Renewal Environmental Regulatory Requirements (Sheet 2 of 4)

Description	Requirement	ER Section(s)
Alternatives in the report including a discussion of whether the alternatives will comply with such applicable environmental quality standards and requirements	10 CFR 51.45(d)	9.7
Information submitted pursuant to 10 CFR 51.45(b) through (d) and not confined to information supporting the proposed action but also including adverse information	10 CFR 51.45(e)	4.0 and 6.3
Operating License Renewal Stage [10 CFR 51.53(c)]		
Description of the proposed action including the applicant's plans to modify the facility or its administrative control procedures as described in accordance with §54.21. The report must describe in detail the affected environment around the plant, the modifications directly affecting the environment or any plant effluents, and any planned refurbishment activities.	10 CFR 51.53(c)(2)	2.1, 2.3, 2.4, 3.0, and 4.0
Analyses of the environmental impacts of the proposed action, including the impacts of refurbishment activities, if any, associated with license renewal and the impacts of operation during the renewal term, for applicable Category 2 issues, as discussed below	10 CFR 51.53(c)(3)(ii)	2.3 and 4.0
Surface Water Resources		
Surface water use conflicts (plants with cooling ponds or cooling towers using makeup water from a river)	10 CFR 51.53(c)(3)(ii)(A)	4.5.1
Groundwater Resources		
Groundwater use conflicts (plants with closed-cycle cooling systems that withdraw makeup water from a river)	10 CFR 51.53(c)(3)(ii)(A)	4.5.2
Groundwater use conflicts (plants that withdraw more than 100 gallons per minute)	10 CFR 51.53(c)(3)(ii)(C)	4.5.3
Groundwater quality degradation (plants with cooling ponds at inland sites)	10 CFR 51.53(c)(3)(ii)(D)	4.5.4
Radionuclides released to groundwater	10 CFR 51.53(c)(3)(ii)(P)	4.5.5

Table 1.0-1
Environmental Report Responses to License Renewal Environmental Regulatory Requirements (Sheet 3 of 4)

Description	Requirement	ER Section(s)
Aquatic Resources		
Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)	10 CFR 51.53(c)(3)(ii)(B)	4.6.1
Thermal impacts on aquatic organisms (plants with once-through cooling systems or cooling ponds)	10 CFR 51.53(c)(3)(ii)(B)	4.6.2
Water use conflicts with aquatic resources (plants with cooling ponds or cooling towers using makeup water from a river	10 CFR 51.53(c)(3)(ii)(A)	4.6.3
Terrestrial Resources		
Water use conflicts with terrestrial resources (plants with cooling ponds or cooling towers using makeup water from a river)	10 CFR 51.53(c)(3)(ii)(A)	4.6.4
Effects on terrestrial resources (non-cooling system impacts)	10 CFR 51.53(c)(3)(ii)(E)	4.6.5
Special Status Species and Habitats		
Threatened, endangered, and protected species, and essential fish habitat	10 CFR 51.53(c)(3)(ii)(E)	4.6.6
Historic and Cultural Resources		
Historic and cultural resources	10 CFR 51.53(c)(3)(ii)(K)	4.7
Human Health		
Microbiological hazards to the public (plants with cooling ponds or canals, or cooling towers that discharge to a river)	10 CFR 51.53(c)(3)(ii)(G)	4.9.1
Electric shock hazards	10 CFR 51.53(c)(3)(ii)(H)	4.9.2
Environmental Justice		
Minority and low-income populations	10 CFR 51.53(c)(3)(ii)(N)	3.11.2 and 4.10.1
Cumulative Impacts		
Cumulative impacts	10 CFR 51.53(c)(3)(ii)(O)	4.12

Table 1.0-1
Environmental Report Responses to License Renewal Environmental Regulatory Requirements (Sheet 4 of 4)

Description	Requirement	ER Section(s)
Severe Accident Mitigation Alternatives		
Severe accidents	10 CFR 51.53(c)(3)(ii)(L)	4.15
All Plants		
Consideration of alternatives for reducing adverse impacts for all Category 2 license renewal issues	10 CFR 51.53(c)(3)(iii)	4.0 and 6.2
New and significant information regarding the environmental impacts of license renewal of which the applicant is aware	10 CFR 51.53(c)(3)(iv)	4.0 and 5.0

1.2 Environmental Report Scope and Methodology

NRC regulations for domestic licensing of nuclear power plants require reviews of environmental impacts from renewing an OL. NRC regulation 10 CFR 51.53(c) requires that an applicant for license renewal submit with its application a separate document (Appendix E of the application) entitled, "Applicant's Environmental Report—Operating License Renewal Stage." In determining what information to include in the PTN SLR applicant's ER, FPL has relied on NRC regulations and the following supporting documents that provide additional insight into the regulatory requirements:

- NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), Revision 1 (NRC 2013a), and referenced information specific to transportation (NRC 1999)
- NRC supplemental information in the *Federal Register* (78 FR 37282)
- *Regulatory Analysis for Amendments to Regulations for the Environmental Review for Renewal of Nuclear Power Plant Operating Licenses* (NRC 1996a)
- Regulatory Guide 4.2, Supplement 1, Revision 1, *Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications* (NRC 2013b)

1.3 Turkey Point Station Licensee and Ownership

FPL is a principal subsidiary of NextEra Energy Inc. (formerly FPL Group, Inc.), and the third-largest electric utility in the United States. FPL is a Juno Beach, Florida-based utility company serving approximately 4.9 million customer accounts or an estimated 10 million people across nearly half of the state of Florida. PTN is owned and operated by FPL, the licensee and applicant.

4.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION AND MITIGATING ACTIONS

> The report must contain a consideration of alternatives for reducing adverse impacts . . . for all Category 2 license renewal issues . . . . [10 CFR 51.53(c)(3)(iii)]
>
> The environmental report must include an analysis that considers . . . the environmental effects of the proposed action . . . and alternatives available for reducing or avoiding adverse environmental effects. [10 CFR 51.45(c)]
>
> The environmental report shall . . . discuss . . . the impact of the proposed action on the environment. Impacts shall be discussed in proportion to their significance. [10 CFR 51.45(b)(1)]
>
> The information submitted . . . should not be confined to information supporting the proposed action but should also include adverse information. [10 CFR 51.45(e)]

The NRC has identified and analyzed 78 environmental issues that it considers to be associated with nuclear power plant license renewal and has designated the issues as Category 1, Category 2, or not categorized (NRC 2013a). The NRC designated an issue as Category 1 if the following criteria were met:

- The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic.
- A single significance level (i.e., small, moderate, or large) has been assigned to the impacts that would occur at any plant, regardless of which plant is being evaluated (except for offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste [HLW]).
- Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely to be not sufficiently beneficial to warrant implementation.

If the NRC concluded that one or more of the Category 1 criteria could not be met, the NRC designated the issue Category 2, which requires plant-specific analysis. The NRC designated one issue as not categorized (human health chronic effects of electromagnetic fields), signifying that the categorization and impact definitions do not apply to this issue. Until such time that this NA issue is categorized, applicants for license renewal are not required to submit information on this issue [10 CFR Part 51, Subpart A, Appendix B, Table B-1, Footnote 6]; therefore, this issue is not included in Tables 4.0-1, 4.0-2, or 4.0-3, nor is it addressed in Section 4.9. NRC rules do not require analyses of Category 1 issues that were resolved using generic findings [10 CFR Part 51, Subpart A, Appendix B, Table B-1] as described in the GEIS. Therefore, an applicant may reference the GEIS findings for Category 1 issues, absent new and significant information.

4.0.1 Category 1 License Renewal Issues

> The environmental report for the operating license renewal stage is not required to contain analyses of the environmental impacts of the license renewal issues identified as Category 1 issues in Appendix B to subpart A of this part. [10 CFR 51.53(c)(3)(i)]

> [A]bsent new and significant information, the analyses for certain impacts codified by this rulemaking need only be incorporated by reference in an applicant's environmental report for license renewal . . . . [61 FR 28483]

FPL has determined that, of the 60 Category 1 issues, 9 are not applicable to PTN. Table 4.0-1 lists these 9 issues and provides a brief explanation of why they are not applicable to the site. Table 4.0-2 lists the 51 Category 1 issues applicable to the site. FPL reviewed the NRC findings on these 51 Category 1 issues and identified no new and significant information that would invalidate the findings for the site (Chapter 5). The new and significant review did evaluate new information such as the findings of state and local agencies regarding the westward movement of hypersaline groundwater. Finding compliance with CAs and orders would result in insignificant impacts for the SLR term.Therefore, FPL adopts by reference the NRC findings for these Category 1 issues.

4.0.2 Category 2 License Renewal Issues

> The environmental report must contain analyses of the environmental impacts of the proposed action, including the impacts of refurbishment activities, if any, associated with license renewal and the impacts of operation during the renewal term, for those issues identified as Category 2 issues in Appendix B to subpart A of this part. [10 CFR 51.53(c)(3)(ii)]

> The report must contain a consideration of alternatives for reducing adverse impacts, as required by § 51.45(c), for all Category 2 license renewal issues . . . . [10 CFR 51.53(c)(3)(iii)]

The NRC designated 17 issues as Category 2. FPL has determined that, of the 17 issues shown in Table 4.0-3, five issues are not applicable to PTN because they apply to plants with natural setting features that do not exist at the facility, or the regulatory basis or requirement of the issue does not apply. Where the issue does not apply to the site, the section explains the basis.

For the 12 issues applicable to the site, the corresponding sections contain the required analyses. These analyses include conclusions regarding the significance of the impacts relative to renewal of the PTN OLs and, when applicable, discuss potential mitigation alternatives to the extent appropriate. With the exception of threatened and endangered species/EFH, historic and cultural resources, and environmental justice, FPL has identified the significance of the impacts associated with each issue as SMALL, MODERATE, or LARGE consistent with the criteria the NRC established in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, Footnote 3, as follows:

> **SMALL**: Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered small.
>
> **MODERATE**: Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
>
> **LARGE**: Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource. For issues where probability is a key consideration (i.e., accident consequences), probability was a factor in determining significance.

Threatened and endangered species/EFH, historic and cultural resources, and environmental justice were not assigned a significance impact of SMALL, MODERATE, or LARGE in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. Therefore consistent with NRC guidance, FPL identified the significance of the impacts for these three Category 2 issues as follows:

- For threatened and endangered species (ESA), the significance of the effects from license renewal can be characterized based on a determination of whether continued nuclear power plant operations, including refurbishment, (1) would have no effect on federally listed species; (2) are not likely to adversely affect federally listed species; (3) are likely to adversely affect federally listed species; or (4) are likely to jeopardize a federally listed species or adversely modify designated critical habitat. For EFH (MSA), the significance of effects from license renewal can be characterized based on a determination of whether continued nuclear power plant operations, including refurbishment, would have (1) no adverse impact; (2) minimal adverse impact; or (3) substantial adverse impact to the essential habitat of federally managed fish populations.

- For historic and cultural resources (NHPA), the significance of the effects from license renewal can be characterized based on a determination that (1) no historic properties are present (no effect); (2) historic properties are present but not adversely affected (no adverse effect); or (3) historic properties are adversely affected (adverse effect).

- For environmental justice, impacts would be based on disproportionately high and adverse human health and environmental effects on minority and low-income populations.

In accordance with NEPA practice, FPL considered ongoing and potential additional mitigation in proportion to the significance of the impact to be addressed (i.e., impacts that are small receive less mitigation consideration than impacts that are large).

4.0.3 Uncategorized License Renewal Issues

The NRC determined that its categorization and impact-finding definitions did not apply to chronic effects of electromagnetic fields. Because the categorization and impact finding definitions do not apply as noted in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, Footnote 5, applicants are not currently required to submit information on this issue.

4.0.4 Format of Issues Reviewed

The review and analysis of the Category 1 and 2 issues identified in NRC Regulatory Guide 4.2, Supplement 1, Revision 1 (NRC 2013b), are discussed in the following sections. The format for the review of these issues is described below. Although Chapter 5 describes the process by which Category 1 issues have been evaluated for new and significant information, specific issues are also being listed in this chapter for consistency purposes with the recommended NRC Regulatory Guide 4.2, Supplement 1 format.

Issue: Title of the issue.

Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1: The findings for the issue from 10 CFR Part 51, Subpart A, Appendix B, Table B-1, Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants.

Requirement: Restatement of the applicable 10 CFR 51.53 requirement.

Background: A background excerpt from the applicable section of the GEIS. The specific section of the GEIS is referenced for the convenience of the reader.

Analysis: An analysis of the environmental impact, taking into account information provided in the GEIS and 10 CFR Part 51, Subpart A, Appendix B, as well as current site-specific information. If an issue is not applicable, the analysis lists the explanation. The analysis section also provides a summary conclusion of the environmental impacts and identifies, as applicable, either ongoing or additional planned mitigation measures to reduce adverse impacts. For Category 1 issues listed in this chapter, an analysis is not required absent new and significant information.

Table 4.0-1
Category 1 Issues Not Applicable to PTN

Resource Issue	Comment
Land Use	
Offsite land use in transmission line ROWs	All in-scope transmission lines subject to the evaluation of environmental impacts for license renewal are located completely within the PTN site.
Surface Water Resources	
Altered current patterns at intake and discharge structures	PTN relies on cooling canals that are manmade features without natural currents that affect waters of the U.S.
Altered thermal stratification of lakes	PTN does not withdraw water from or discharge to a lake.
Surface water use conflicts (plants with once-through cooling systems)	PTN does not use a once-through cooling system.
Temperature effects on sediment transport capacity	PTN does not discharge to a natural water body that has sediment transport capacity.
Groundwater Resources	
Groundwater use conflicts (plants that withdraw less than 100 gallons per minute)	PTN withdraws groundwater at quantities greater than 100 gallons per minute.
Terrestrial Resources	
Cooling tower impacts on vegetation (plants with cooling towers)	PTN does not use cooling towers.
Aquatic Resources	
Impingement and entrainment of aquatic organisms (plants with cooling towers)	PTN does not use cooling towers.
Thermal impacts on aquatic organisms (plants with cooling towers)	PTN does not use cooling towers.

Table 4.0-2
Category 1 Issues Applicable to PTN (Sheet 1 of 3)

Resource Issue	Subcategory
Land Use	Onsite land uses
	Offsite land uses
Visual Resources	Aesthetic impacts
Air Quality	Air quality impacts (all plants)
	Air quality effects of transmission lines
Noise	Noise impacts
Geologic Environment	Geology and soils
Surface Water Resources	Surface water use and quality (non-cooling system impacts)
	Altered salinity gradients
	Scouring caused by discharged cooling water
	Discharge of metals in cooling system effluent
	Discharge of biocides, sanitary wastes, and minor chemical spills
	Effects of dredging
Groundwater Resources	Groundwater contamination and use (non-cooling system impacts)
	Groundwater quality degradation resulting from water withdrawals
	Groundwater quality degradation (plants with cooling ponds in salt marshes)
Terrestrial Resources	Exposure of terrestrial organisms to radionuclides
	Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds)
	Bird collisions with plant structures and transmission lines
	Transmission line ROW management impacts on terrestrial resources
	Electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)

Table 4.0-2
Category 1 Issues Applicable to PTN (Sheet 2 of 3)

Resource Issue	Subcategory
Aquatic Resources	Entrainment of phytoplankton and zooplankton (all plants)
	Infrequently reported thermal impacts (all plants)
	Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication
	Effects of nonradiological contaminants on aquatic organisms
	Exposure of aquatic organisms to radionuclides
	Effects of dredging on aquatic organisms
	Effects on aquatic resources (non-cooling system impacts)
	Impacts of transmission line ROW management on aquatic resources
	Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses
Socioeconomics	Employment and income, recreation and tourism
	Tax revenues
	Community services and education
	Population and housing
	Transportation
Human Health	Radiation exposures to the public
	Radiation exposures to plant workers
	Human health impact from chemicals
	Microbiological hazards to plant workers
	Physical occupational hazards
Postulated Accidents	Design-basis accidents

Table 4.0-2
Category 1 Issues Applicable to PTN (Sheet 3 of 3)

Resource Issue	Subcategory
Waste Management	Low-level waste storage and disposal
	Onsite storage of spent nuclear fuel
	Offsite radiological impacts of spent nuclear fuel and high-level waste disposal
	Mixed-waste storage and disposal
	Nonradioactive waste storage and disposal
Uranium Fuel Cycle	Offsite radiological impacts—individual impacts from other than the disposal of spent fuel and high-level waste
	Offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste
	Nonradiological impacts of the uranium fuel cycle
	Transportation
Termination of Nuclear Power Plant Operations and Decommissioning	Termination of plant operations and decommissioning

Table 4.0-3
Category 2 Issues Applicability to PTN (Sheet 1 of 2)

Resource Issue	Applicability	ER Section
Surface Water Resources		
Surface water use conflicts (plants with cooling ponds or cooling towers using makeup water from a river)	Not applicable	4.5.1
Groundwater Resources		
Groundwater use conflicts (plants that withdraw more than 100 gallons per minute)	Applicable	4.5.3
Groundwater use conflicts (plants with closed-cycle cooling systems that withdraw makeup water from a river)	Not applicable	4.5.2
Groundwater quality degradation (plants with cooling ponds at inland sites)	Not applicable	4.5.4
Radionuclides released to groundwater	Applicable	4.5.5
Terrestrial Resources		
Effects on terrestrial resources (non-cooling system impacts)	Applicable	4.6.5
Water use conflicts with terrestrial resources (plants with cooling ponds or cooling towers using makeup water from a river)	Not applicable	4.6.4
Aquatic Resources		
Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)	Applicable	4.6.1
Thermal impacts on aquatic organisms (plants with once-through cooling systems or cooling ponds)	Applicable	4.6.2
Water use conflicts with aquatic resources (plants with cooling ponds or cooling towers using makeup water from a river)	Not applicable	4.6.3
Special Status Species and Habitats		
Threatened, endangered, and protected species and essential fish habitat	Applicable	4.6.6
Historic and Cultural Resources		
Historic and cultural resources	Applicable	4.7

Table 4.0-3
Category 2 Issues Applicability to PTN (Sheet 2 of 2)

Resource Issue	Applicability	ER Section
Human Health		
Microbiological hazards to the public (plants with cooling ponds or canals or cooling towers that discharge to a river)	Applicable	4.9.1
Electric shock hazards	Applicable	4.9.2
Postulated Accidents		
Severe accidents	Applicable	4.15
Environmental Justice		
Minority and low-income populations	Applicable	4.10.1
Cumulative Impacts		
Cumulative impacts	Applicable	4.12

4.1 Land Use and Visual Resources

The following sections address the land use issues applicable to PTN, providing background on the issues and the analyses regarding the SLR period.

4.1.1 Onsite Land Use

4.1.1.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL. Changes in onsite land use from continued operations and refurbishment associated with license renewal would be a small fraction of the nuclear power plant site and would involve only land that is controlled by the licensee.

4.1.1.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.1.1.3 Background [GEIS Section 4.2.1.1]

Operational activities at a nuclear power plant during the license renewal term would be similar to those occurring during the current license term. Generally, onsite land use conditions would remain unchanged. However, additional spent nuclear fuel and LLRW generated during the license renewal term could require the construction of new or expansion of existing onsite storage facilities. Should additional storage facilities be required, this action would be addressed in separate license reviews conducted by the NRC. Refurbishment activities, such as steam generator and vessel head replacement, have not permanently changed onsite land use conditions.

4.1.1.4 Analysis

Onsite land use information is presented in Section 3.2.1. No license renewal-related refurbishment activities have been identified, as discussed in Section 2.3. In addition, no license renewal-related construction activities have been identified. Therefore, no changes in onsite land use during the SLR period are anticipated.

In the GEIS, the NRC determined that onsite land use impacts from continued plant operations over the license renewal term would be SMALL for all nuclear plants, and designated this as a Category 1 issue (NRC 2013a, Section 4.2.1.1). Based on FPL's review, no new and significant information was identified as it relates to onsite land use, and further analysis is not required.

4.1.2 Offsite Land Use

4.1.2.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL. Offsite land use would not be affected by continued operations and refurbishment associated with license renewal.

4.1.2.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.1.2.3 Background [GEIS Section 4.2.1.1]

The impacts of continued plant operations during the license renewal term and refurbishment on offsite land use were evaluated separately in the 1996 GEIS. It was predicted that impacts associated with refurbishment and changes in population and tax revenue on offsite land use could range from SMALL to MODERATE. License renewal reviews, however, have shown no power plant-related population changes or significant tax revenue changes due to license renewal. Non-outage employment levels at nuclear power plants have remained relatively unchanged or have decreased. With no increase in the number of workers, there has been no increase in housing, infrastructure, or demand for services beyond what has already occurred. Operational activities during the license renewal term would be similar to those occurring during the current license term and would not affect offsite land use beyond what has already been affected.

For plants that have the potential to impact a coastal zone or coastal watershed, as defined by each state participating in the national Coastal Zone Management Program, applicants for license renewal must submit to the affected state a certification that the proposed license renewal is consistent with the state Coastal Zone Management Program. Applicants must coordinate with the state agency that manages the state Coastal Zone Management Program to obtain a determination that the proposed nuclear plant license renewal would be consistent with the state program.

4.1.2.4 Analysis

Offsite land use information is presented in Section 3.2.2. As discussed in Section 2.5, there are no plans to add workers to support plant operations during the SLR period and, as discussed in Section 2.3, no license renewal-related refurbishment activities have been identified. Therefore, no changes in offsite land use during the SLR period are anticipated.

In the GEIS, the NRC determined that offsite land use impacts from continued plant operations over the license renewal term would be SMALL for all nuclear plants, and designated this as a Category 1 issue (NRC 2013a, Section 4.2.1.1). Additionally, as detailed in Section 9.5.10, PTN has fulfilled the regulatory requirement to certify to the licensing agency that the proposed activity would be consistent with the state's federally approved coastal zone management program. Based on FPL's review, no new and significant information was identified as it relates to offsite land use, and further analysis is not required.

4.1.3 Offsite Land Use of Transmission Line Rights-of-Way

4.1.3.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL. Use of transmission line ROWs from continued operations and refurbishment associated with license renewal would continue with no change in land use restrictions.

4.1.3.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.1.3.3 Background [GEIS Section 4.2.1.1]

Operational activities in offsite transmission line ROWs, within this scope of review, during the license renewal term, would be similar to those occurring during the current license term and would not affect offsite land use in transmission line ROWs beyond what has already been affected. Certain land-use activity in the ROW is usually restricted. Land cover is generally managed through a variety of maintenance procedures so that vegetation growth and building construction do not interfere with power line operation and access. Land use within ROWs are limited to activities that do not endanger power line operation; these include recreation, off-road vehicle use, grazing, agricultural cultivation, irrigation, roads, environmental conservation, and wildlife areas. Transmission lines do not preclude the use of the land for farming or environmental and recreational use. Transmission lines connecting nuclear power plants to the electrical grid are no different from transmission lines connecting any other power plant.

4.1.3.4 Analysis

As discussed in Section 2.2.5, in-scope transmission lines are located completely within PTN property (see Figure 2.2-4). Therefore, this issue is not applicable, and further analysis is not required.

4.1.4 Aesthetics Impacts

4.1.4.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL. No important changes to the visual appearance of plant structures or transmission lines are expected from continued operations and refurbishment associated with license renewal.

4.1.4.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.1.4.3 Background [GEIS Section 4.2.1.2]

A case study performed for the 1996 GEIS found a limited number of situations where nuclear power plants had a negative effect on visual resources. Negative perceptions were based on aesthetic considerations (for instance, the plant is out of character or scale with the community or the viewshed), physical environmental concerns, safety and perceived risk issues, an anti-plant attitude, or an anti-nuclear orientation. It is believed that these negative perceptions would persist regardless of mitigation measures.

In addition, the visual appearance of transmission lines is not expected to change during the license renewal term. After the containment building and cooling towers, transmission line towers are probably the most frequently observed structure associated with nuclear power plants. Transmission lines from nuclear power plants are generally indistinguishable from those from other power plants. Because electrical transmission lines are common throughout the United States, they are generally perceived with less prejudice than the nuclear power plant itself. Also, the visual impact of transmission lines tends to wear off when viewed repeatedly.

4.1.4.4 Analysis

The visual appearance of the plant is presented in Section 3.2.3. As described in Section 2.2.5 and shown in Figure 2.2-4, the in-scope transmission lines do not contribute to the visual impacts of the site. As discussed in Section 3.2.3, Turkey Point is located in an unincorporated area in southeastern Miami-Dade County, Florida. There is sufficient vegetation to screen the existing units from roadways and recreational areas on land. The existing units are not visible from most areas within Biscayne National Park and Homestead Bayfront Park. The site is not visible beyond 6 miles from land. However, the site is visible for many miles from Biscayne Bay. At night, light from PTN is visible from several points in the vicinity. No refurbishment or construction activities have been identified that would change the aesthetics of the Turkey Point facility during the SLR term. Therefore, no changes in visual resources during the SLR period are anticipated.

In the GEIS, the NRC determined that aesthetic impacts from continued plant operations over the license renewal term would be SMALL for all nuclear plants, and designated this as a Category 1 issue (NRC 2013a, Section 4.2.1.2). Based on FPL's review, no new and significant information was identified as it relates to visual resources, and further analysis is not required.

4.2 Air Quality

The following sections address the air quality issues applicable to PTN, providing background on the issues and the analyses regarding the SLR period.

4.2.1 Air Quality Impacts (all plants)

4.2.1.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

The NRC has made the following generic findings for all plants regarding air quality impacts from nuclear plants:

SMALL. Air quality impacts from continued operations and refurbishment associated with license renewal are expected to be small at all plants. Emissions resulting from refurbishment activities at locations in or near air quality nonattainment or maintenance areas would be short-lived and would cease after these refurbishment activities are completed. Operating experience has shown that the scale of refurbishment activities has not resulted in exceedance of the *de minimis* thresholds for criteria pollutants, and BMPs including fugitive dust controls and the imposition of permit conditions in state and local air emissions permits would ensure conformance with applicable state or tribal implementation plans.

Emissions from emergency diesel generators (EDGs) and fire pumps and routine operations of boilers used for space heating would not be a concern, even for plants located in or adjacent to nonattainment areas. Impacts from cooling tower particulate emissions even under the worst-case situations have been small.

4.2.1.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.2.1.3 Background [GEIS Section 4.3.1.1]

Impacts on air quality during normal plant operations can result from operations of fossil fuel-fired equipment needed for various plant functions. Each licensed plant typically employs EDGs for use as a backup power source. EDGs and fire pumps typically require state or local operating permits. These diesel generators are typically tested once a month with several test burns of various durations (e.g., 1 to several hours). In addition to these maintenance tests, longer-running endurance tests are also typically conducted at each plant. Each generator is typically tested for 24 hours on a staggered test schedule (e.g., once every refueling outage).

In addition to the EDGs, fossil fuel (i.e., diesel-, oil-, or natural gas-fired) boilers are used primarily for evaporator heating, plant space heating, and/or feed water purification. These units typically operate at a variable load on a continuous basis throughout the year unless end use is restricted to one application, such as space heating. The utility boilers at commercial plants are relatively small when compared with most industrial boilers and are typically regulated through state-level operating permits.

As discussed in Section 3.3 of the GEIS, cooling tower drift can increase downwind PM concentrations, impair visibility, ice roadways, cause drift deposition, and damage vegetation and painted surfaces. Thus, although there is the potential for some air quality impacts to occur as a result of equipment and cooling tower operations, even in the worst-case situation (Hope Creek), the impacts have been small, and licensees would be required to operate within state permit requirements.

In the 1996 GEIS, the NRC concluded that the impacts from plant refurbishment associated with license renewal on air quality could range from SMALL to LARGE, although these impacts were expected to be SMALL for most plants. However, findings from license renewal Supplemental Environmental Impact Statements (SEISs) published since the 1996 GEIS have shown that refurbishment activities, such as steam generator and vessel head replacement, have not required the large numbers of workers and months of time, as well as the degree of land disturbance that was conservatively estimated in the 1996 GEIS. Presumed air pollutant emissions, including levels of fugitive dust, have therefore not been realized.

4.2.1.4 Analysis

Air quality information is presented in Section 3.3.3. No license renewal-related refurbishment activities have been identified, as discussed in Section 2.3. As stated in the GEIS (NRC 2013a), BMPs, including fugitive dust controls and the imposition of permit conditions in FDEP air emissions permits, would ensure conformance with applicable state implementation plans.

As discussed in Section 3.3.3.1, Miami-Dade County is in attainment with the NAAQS for all criteria air pollutants. As discussed in Section 3.3.3.2, no future upgrade or replacement activities (e.g., diesel generators, diesel pumps) that would increase or decrease air emissions over the SLR period were identified as necessary for plant operations. As indicated in Section 3.3, a pump replacement is planned and the Title V permit would be amended as necessary.

The Turkey Point Title V facility is composed of two separate co-located power plants: the fossil plant (Unit 5) and the nuclear plant (Units 3 and 4). The non-nuclear operations of PTN are permitted by a Title V air emissions permit (Permit No. 0250003-021-AV). The operations of the fossil plant are addressed in a separate Title V permit. (FDEP 2014a) As discussed in Section 3.3.3.2 and Chapter 9, PTN and ancillary facilities have received a site certification in accordance with the Florida PPSA. This process provides a certification that encompasses all licenses and permits needed for affected Florida state, regional, and local agencies. The conditions of certification require FPL to comply with the provisions and limitations set forth in its Title V air operation permit (FDEP 2016a). The PTN air permit contains conditions established by the FDEP to protect Florida's ambient air quality standards and ensure impacts are maintained at acceptable levels. Appropriate permit conditions would regulate any future PTN activities that may increase air pollutants or threaten the attainment status of Miami-Dade County. Compliance with current and future air emissions regulatory requirements, applicable emissions control measures, and reporting requirements will ensure continued SMALL impact on ambient air quality.

In the GEIS, the NRC determined that air quality impacts from continued plant operations over the license renewal term would be SMALL for all nuclear plants, and designated this as a Category 1 issue (NRC 2013a, Section 4.3.1.1). Based on FPL's review, no new and significant information was identified as it relates to air quality, and further analysis is not required.

4.2.2 Air Quality Effects of Transmission Lines

4.2.2.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL. Production of ozone and oxides of nitrogen is insignificant and does not contribute measurably to ambient levels of these gases.

4.2.2.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.2.2.3 Background [GEIS Section 4.3.1.1]

Small amounts of ozone and substantially smaller amounts of oxides of nitrogen are produced by transmission lines during corona, a phenomenon that occurs when air ionizes near isolated irregularities on the conductor surface such as abrasions, dust particles, raindrops, and insects. Several studies have quantified the amount of ozone generated and concluded that the amount produced by even the largest lines in operation (765 kV) is insignificant.

Ozone concentrations generated by transmission lines are therefore too low to cause any significant effects. The minute amounts of oxides of nitrogen produced are similarly insignificant. A finding of SMALL significance for transmission lines, within this scope of review is supported by the evidence that production of ozone and oxides of nitrogen are insignificant and does not measurably contribute to ambient levels of those gases.

4.2.2.4 Analysis

Based on the GEIS, it was determined through several studies that the amount of ozone generated by even the largest lines in operation (765 kV) would be insignificant (NRC 2013a, Section 4.3.1.1). As discussed in Section 2.2.5, Turkey Point's in-scope transmission lines are 230 kV. Therefore, the production of ozone and oxides of nitrogen would be *de minimis*.

In the GEIS, the NRC determined that air quality effects of transmission lines from continued plant operations over the license renewal term would be SMALL for all nuclear plants, and designated this as a Category 1 issue (NRC 2013a, Section 4.3.1.1). Based on FPL's review, no new and significant information was identified as it relates to air quality effects of transmission lines, and further analysis is not required.

4.3 Noise

The following sections address the noise issues applicable to PTN, providing background on the issues and the analyses regarding the SLR period.

4.3.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL. Noise levels would remain below regulatory guidelines for offsite receptors during continued operations and refurbishment associated with license renewal.

4.3.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.3.3 Background [GEIS Section 4.3.1.2]

Major sources of noise at operating nuclear power plants are cooling towers, turbines, transformers, large pumps, and cooling water system motors. Nuclear plant operations have not changed appreciably with time, and no change in noise levels or noise-related impacts are expected during the license renewal term. Because no change is expected in the amount of noise generated during the license renewal term, the only issue of concern is the number of people now living close to the nuclear power plant who are exposed to operational noise.

Given the industrial nature of the power plant and the number of years of plant operation, noise from a nuclear plant is generally nothing more than a continuous minor nuisance. However, noise levels may sometimes exceed the 55 dBA level that the EPA uses as a threshold level to protect against excess noise during outdoor activities. However, according to the EPA, this threshold does "not constitute a standard, specification, or regulation," but was intended to provide a basis for state and local governments establishing noise standards. Nevertheless, noise levels at the site boundary are expected to remain well below regulatory standards for offsite residents.

Noise would also be generated by construction-related activities and equipment used during refurbishment. However, this noise would occur for relatively short periods of time (several weeks) and is not expected to be distinguishable from other operational noises at the site boundary nor create an adverse impact on nearby residents.

4.3.4 Analysis

Noise associated with plant operations is presented in Section 3.4. As discussed in Section 3.4, a noise monitoring survey which included noise from PTN was performed in June 2008 as part of the Turkey Point Units 6 and 7 COL application ER. The survey indicated that the baseline Ldn value is below the 65 dBA acceptance limit. Turkey Point Units 6 and 7 would be collocated with PTN; therefore, the noise study is also considered applicable to PTN.

No license renewal-related refurbishment activities have been identified, as discussed in Section 2.3. As discussed in Section 3.4, because Turkey Point is located in a rural area away from urban areas, it is unlikely that noise levels from Turkey Point would affect offsite residences. The nearest residence to PTN, as defined in the PTN AREOR, is located approximately 1.7 miles west-northwest of the PTN generating station area. These are identified as the FPL daycare center and shooting range near the entrance to PTN. The Homestead Bayfront Park complex is located 1.9 miles north of the plant and has occasional overnight recreational occupancy. (PTN 2017b) There are no applicable state or local environmental noise regulations for unincorporated areas of Miami-Dade County, where Turkey Point is located. As discussed in Section 3.4, there have been no noise complaints associated with Turkey Point's plant operations in the previous 5 years (2012–2016).

In the GEIS, the NRC determined that noise impacts from continued plant operations over the license renewal term would be SMALL for all nuclear plants, and designated this as a Category 1 issue (NRC 2013a, Section 4.3.1.2). Based on Turkey Point's review, no new and significant information was identified as it relates to noise, and further analysis is not required.

4.4 Geology and Soils

The following sections address the geology and soils issues applicable to PTN, providing background on the issues and the analyses regarding the SLR period.

4.4.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL. The effect of geologic and soil conditions on plant operations and the impact of continued operations and refurbishment activities on geology and soils would be small for all nuclear power plants and would not change appreciably during the license renewal term.

4.4.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.4.3 Background [GEIS Section 4.4.1]

The impact of continued operations and refurbishment associated with license renewal on geologic and soil resources would consist of soil disturbance, including sediment and/or any associated bedrock, for projects, such as replacing or adding buildings, roads, parking lots, and below-ground and above-ground utility structures. Implementing BMPs would reduce soil erosion and subsequent impacts on surface water quality. These practices include, but are not limited to, minimizing the amount of disturbed land, stockpiling topsoil before ground disturbance, mulching and seeding in disturbed areas, covering loose materials with geotextiles, using silt fences to reduce sediment loading to surface water, using check dams to minimize the erosive power of drainages, and installing proper culvert outlets to direct flows in streams or drainages.

Detailed geotechnical analyses would be required to address the stability of excavations, foundation footings, and slope cuts for building construction, road creation, or other refurbishment-related construction projects. Depending on the plant location and design, riverbank or coastline protection might need to be upgraded, especially at water intake or discharge structures, if natural flows, such as storm surges, cause an increase in erosion. In addition, the FPPA [7 USC 4201 et seq.] requires federal agencies to take into account agency actions affecting the preservation of farmland, including prime and other important farmland soils, as described in Section 3.4 of the GEIS.

4.4.4 Analysis

Geology and soils information is presented in Section 3.5. Routine infrastructure, renovation, and maintenance projects would be expected during continued operation. As discussed in Section 3.5.3.2, stabilization measures are in place to prevent erosion and sedimentation impacts to the site and vicinity because PTN has been operational since the early 1970s.

In the GEIS, the NRC determined that geology and soil impacts from continued plant operations over the license renewal term would be SMALL for all nuclear plants, and designated this as a Category 1 issue (NRC 2013a, Section 4.4.1). Based on FPL's review, no new and significant information was identified as it relates to geology and soils, and further analysis is not required.

4.5 Water Resources

The following sections address the water resources issues applicable to PTN, providing background on the issues and the analyses regarding the SLR period.

4.5.1 Surface Water Use Conflicts (Plants with Cooling Ponds or Cooling Towers Using Makeup Water from a River)

4.5.1.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL or MODERATE. Impacts could be of small or moderate significance, depending on makeup water requirements, water availability, and competing water demands.

4.5.1.2 Requirement [10 CFR 51.53(c)(3)(ii)(A)]

If the applicant's plant utilizes cooling towers or cooling ponds and withdraws makeup water from a river, an assessment of the impact of the proposed action on water availability and competing water demands, the flow of the river . . . must be provided.

4.5.1.3 Background [GEIS Section 4.5.1.1]

Nuclear power plant cooling systems may compete with other users relying on surface water resources, including downstream municipal, agricultural, or industrial users. Closed-cycle cooling is not completely closed, because the system discharges blowdown water to a surface water body and withdraws water for makeup of both the consumptive water loss due to evaporation and drift (for cooling towers) and blowdown discharge. For plants using cooling towers, the makeup water needed to replenish the consumptive loss of water to evaporation can be significant and is reported at 60 percent or more of the condenser flow rate. Cooling ponds will also require makeup water as a result of naturally occurring evaporation, evaporation of the warm effluent, and possible seepage to groundwater.

Consumptive use by plants with cooling ponds or cooling towers using makeup water from a river during the license renewal term is not expected to change unless power uprates, with associated increases in water use, are proposed. Such uprates would require an environmental assessment by the NRC. In the 1996 GEIS, application of this issue applied only to rivers with low flow so as to define the difference between plants located on "small" versus "large" rivers. However, any river, regardless of size, can experience low flow conditions of varying severity during periods of drought and changing conditions in the affected watershed such as upstream diversions and use of river water. NRC has subsequently determined that use of the term "low flow" in categorizing river flow is of little value considering that all rivers can experience low flow conditions.

Population growth around nuclear power plants has caused increased demand on municipal water systems, including systems that rely on surface water. Municipal intakes located downstream from a nuclear power plant could experience water shortages, especially in times of drought. Similarly, water demands upstream from a plant could impact the water availability at the plant's intake.

Water use conflicts associated with plants with cooling ponds or cooling towers using makeup water from a river with low flow were considered to vary among sites because of differing site-specific factors, such as makeup water requirements, water availability (especially in terms of varying river flow rates), changing or anticipated changes in population distributions, or changes in agricultural or industrial demands.

4.5.1.4 Analysis

As discussed in Section 2.2.3, Turkey Point utilizes a closed-cycle CCS for condenser cooling purposes, but does not withdraw makeup water from a river. PTN does not have a permit to use surface water for consumptive use nor have any plans for surface water consumptive use during the license renewal period. PTN uses approximately 690 gpm of water from the Miami-Dade public water supply system. Plant water use includes process (primary demineralizer water makeup), potable, and fire protection water. (FPL 2014a, Section 2.3.2.1.4.1) The use of municipal water for plant use will be significantly reduced by the end of 2017, when production from the Upper Floridan Aquifer will begin. Therefore, this issue is not applicable, and further analysis is not required.

4.5.2 Groundwater Use Conflicts (Plants with Closed-Cycle Cooling Systems that Withdraw Makeup Water from a River)

4.5.2.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL, MODERATE, or LARGE. Water use conflicts could result from water withdrawals from rivers during low-flow conditions, which may affect aquifer recharge. The significance of impacts would depend on makeup water requirements, water availability, and competing water demands.

4.5.2.2 Requirement [10 CFR 51.53(c)(3)(ii)(A)]

If the applicant's plant utilizes cooling towers or cooling ponds and withdraws makeup water from a river, an assessment of the impact of the proposed action on water availability and competing water demands . . . must be provided. The applicant shall also provide an assessment of the impacts of the withdrawal of water from the river on alluvial aquifers during low flow.

4.5.2.3 Background [GEIS Section 4.5.1.2]

In the case of plants with cooling towers or cooling ponds that rely on a river for makeup of consumed (evaporated) cooling water, it is possible water withdrawals from the river could lead to groundwater use conflicts with other users. This situation could occur because of the interaction between groundwater and surface water, especially in the setting of an alluvial aquifer in a river valley. Consumptive use of the river water, if significant enough to lower the river's water level, would also influence water levels in the alluvial aquifer. Shallow wells of nearby groundwater users could therefore have reduced water availability or go dry. During times of drought, the effect would be occurring naturally, although withdrawals for makeup water would increase the effect.

4.5.2.4 Analysis

As discussed in Section 2.2.3, Turkey Point uses its closed-cycle cooling canals in the CCS for condenser cooling purposes, but does not withdraw makeup water from a river. Therefore, this issue is not applicable, and further analysis is not required.

4.5.3 Groundwater Use Conflicts (Plants that Withdraw more than 100 GPM)

4.5.3.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL, MODERATE, or LARGE. Plants that withdraw more than 100 gpm could cause groundwater use conflicts with nearby groundwater users.

4.5.3.2 Requirement [10 CFR 51.53(c)(3)(ii)(C)]

If the applicant's plant pumps more than 100 gallons (total onsite) of groundwater per minute, an assessment of the impact of the proposed action on groundwater must be provided.

4.5.3.3 Background [GEIS Section 4.5.1.2]

A nuclear plant may have several wells, with combined pumping in excess of 100 gpm (378 liters per minute [L/min]). Overall site pumping rates of this magnitude have the potential to create conflicts with other local groundwater users if the cone of depression extends to the offsite well(s). Large offsite pumping rates for municipal, industrial, or agricultural purposes may, in turn, lower the water level at power plant wells. For any user, allocation is normally determined through a state-issued permit.

Groundwater use conflicts have not been observed at any nuclear power plants, and no significant change in water well systems is expected over the license renewal term. If a conflict did occur, it might be possible to resolve it if the power plant relocated its well or wellfield to a different part of the property. The siting of new wells would be determined through a hydrogeologic assessment.

4.5.3.4 Analysis

The FDEP (conditions of certification) allows a maximum Floridan Aquifer withdrawal total of 28.06 MGD:14.00 MGD for salinity reduction in the CCS and 14.06 MGD for Unit 5 cooling water and plant process water (FDEP 2016a). The SFWMD (Permit No. 13-06251-W) allows a maximum withdrawal of groundwater from the Biscayne Aquifer of 5,475 million gallons per year (15,000 gpd or 465 million gallons per month) for use in the capture of hypersaline water in the Biscayne Aquifer using the RWS (SFWMD 2017a). Therefore, the combined permitted groundwater maximum withdrawals from the Floridan Aquifer and Biscayne Aquifer Recovery System is 43.06 MGD. These Biscayne and Floridan Aquifer System withdrawals are permitted by FDEP and the SFWMD. During the permitting process, the impacts of the uses on existing land uses, pre-existing water rights, and the environment are fully evaluated and subject to public review and challenge prior to water rights being granted. In addition, in southern Florida, uses of seawater-quality water (dissolved chloride levels of 19,000 mg/L or above) do not require a permit. FPL maintains three such seawater wells constructed into the Biscayne Aquifer (Point Wells) for CCS freshening in the event of extreme salinity events. The combined capacity of these three wells is 45 MGD.

It is not anticipated that groundwater withdrawal increases above permitted quantities will be required during the license period; therefore, FPL concludes that impacts from groundwater withdrawals are SMALL and do not warrant additional mitigation measures.

4.5.4 Groundwater Quality Degradation (Plants with Cooling Ponds at Inland Sites)

4.5.4.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL, MODERATE, or LARGE. Inland sites with closed-cycle cooling ponds could degrade groundwater quality. The significance of the impact would depend on cooling pond water quality, site hydrogeologic conditions (including the interaction of surface water and groundwater), and the location, depth, and pump rate of water wells.

4.5.4.2 Requirement [10 CFR 51.53(c)(3)(ii)(D)]

If the applicant's plant is located at an inland site and utilizes cooling ponds, an assessment of the impact of the proposed action on groundwater quality must be provided.

4.5.4.3 Background [GEIS Section 4.5.1.2]

Some nuclear power plants that rely on unlined cooling ponds are located at inland sites surrounded by farmland or forest or undeveloped open land. Degraded groundwater has the potential to flow radially from the ponds and reach offsite groundwater wells. The degree to which this occurs depends on the water quality of the cooling pond; site hydrogeologic conditions (including the interaction of surface water and groundwater); and the location, depth, and pump rate of water wells. Mitigation of significant problems stemming from this issue could include lining existing ponds, constructing new lined ponds, or installing subsurface flow barrier walls. Groundwater monitoring networks would be necessary to detect and evaluate groundwater quality degradation. The degradation of groundwater quality associated with cooling ponds has not been reported for any inland nuclear plant sites.

4.5.4.4 Analysis

As discussed in Section 2.2.3, Turkey Point utilizes a closed-loop cooling system with the CCS for condenser cooling purposes. Section 2.2.3 describes the CCS as composed of cooling canals that receive tidal inflow and outflow from the saline aquifer beneath Biscayne Bay. As shown in Section 3.1, Turkey Point's location is coastal rather than inland. Given that this issue is specific to inland sites and the cooling canals groundwater interface is to a marine aquifer, this issue is not applicable, and further analysis is not required. The issue was likewise considered not applicable in the first license renewal ER (FPL 2000b, Section 4.8). The GEIS also identifies Turkey Point's cooling canals as applicable to the Category 1 issue of cooling ponds located in salt marsh (NRC 2013a, Section 4.5.1.2).

4.5.5 Radionuclides Released to Groundwater

4.5.5.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL or MODERATE. Leaks of radioactive liquids from plant components and pipes have occurred at numerous plants. Groundwater protection programs have been established at all operating nuclear power plants to minimize the potential impact from any inadvertent releases. The magnitude of impacts would depend on site-specific characteristics.

4.5.5.2 Requirement [10 CFR 51.53(c)(3)(ii)(P)]

An applicant shall assess the impact of any documented inadvertent releases of radionuclides into groundwater. The applicant shall include in its assessment a description of any groundwater protection program used for the surveillance of piping and components containing radioactive liquids for which a pathway to groundwater may exist. The assessment must also include a description of any past inadvertent releases and the projected impact to the environment (e.g., aquifers, rivers, lakes, ponds, ocean) during the license renewal term.

4.5.5.3 Background [GEIS Section 4.5.1.2]

The issue is relevant to license renewal because all commercial nuclear power plants routinely release radioactive gaseous and liquid materials into the environment. These radioactive releases are designed to be planned, monitored, documented, and released into the environment at designated discharge points. However, within the past several years, there have been numerous events at power reactor sites which involved unknown, uncontrolled, and unmonitored release of liquids containing radioactive material into the groundwater.

The majority of the inadvertent liquid release events involved tritium, which is a radioactive isotope of hydrogen. However, other radioactive isotopes, such as cesium and strontium, have also been inadvertently released into the groundwater. The types of events include leakage from spent fuel pools, buried piping, and failed pressure relief valves on an effluent discharge line.

In 2006, the NRC's Executive Director for Operations chartered a task force to conduct a lessons-learned review of these incidents. On September 1, 2006, the task force issued its report: Liquid Radioactive Release Lessons Learned Task Force Report.

The most significant conclusion dealt with the potential health impacts on the public from the inadvertent releases. Although there were numerous events where radioactive liquid was released to the groundwater in an unplanned, uncontrolled, and unmonitored fashion, based on the data available, the task force did not identify any instances where public health and safety was adversely impacted.

On the basis of the information and experience with these leaks, the NRC concludes that the impact to groundwater quality from the release of radionuclides could be SMALL or MODERATE, depending on the magnitude of the leak, radionuclides involved, hydrogeologic factors, the distance to receptors, and the response time of plant personnel to identify and stop the leak in a timely fashion.

4.5.5.4 Analysis

The Turkey Point groundwater protection program is discussed in Section 3.6.2.5. Table 3.6-2 presents well construction details for the Turkey Point groundwater monitoring wells, while Figures 3.6-10 and 3.6-11 show the location of the wells. Table 3.6-5 presents information on registered water wells within a 5-mile band around the FPL property boundary, while Figure 3.6-12 shows the locations of these registered wells.

As discussed in Section 3.6.4.2.1, tritium migrates with groundwater flow. As discussed in Section 3.6.4.2.1, radwaste releases are discharged to the IWW outfall 001 and mix with waters within the closed-loop IWW/CCS. Radwaste release administrative controls ensure the releases are consistent with the plant permits and do not present an environmental or public health risk. The cooling canals are in direct hydraulic connection to the underlying sediments and coral rock, and a near continuous exchange of surface water in the cooling canals and groundwater within the sediments exists by design. As discussed in Sections 3.6.4.2.1 and 3.6.4.2, groundwater beneath the CCS is saltwater, has been designated as a G-III non-potable groundwater by the FDEP, and is not used as a source of potable or irrigation supply. In addition, facility personnel are provided a municipal source of drinking water. Due to the administrative controls employed for discharges of radwaste, which ensure tritium levels are below public health safety levels, and the use of municipal water for human use, health risks due to human consumption are not credible. The IWW is not open to the public, thereby restricting access. Based on the groundwater and surface water data, none of the potential receptors identified are at a credible risk of exposure to concentrations of tritium. (FPL 2017b, Section 2.10.4)

As discussed in Section 3.6.4.2.1, nine minor unplanned releases of radioactive materials have occurred from 2012 to 2016. All releases have been remediated or monitored to ensure any released radionuclides have not migrated from the release site. Unplanned release events are entered into the CAP for evaluation, correction, and future prevention. For the four unplanned releases with the potential to reach groundwater (e.g., leaks onto soil), Table 3.6-6 presents groundwater monitoring results prior to and for the following year for the unplanned releases. The readings were below reportable levels and do not show a sustained trend. Thus, these unplanned releases would not influence groundwater quality during the SLR term. FPL would continue using its activities to identify unplanned releases, stop them, and enter them into CAP for evaluation, correction, and future prevention.

As discussed in Section 3.6.4.2, Turkey Point's groundwater monitoring program covers the existing quality of groundwater potentially affected by continued operations (as compared to the EPA primary drinking water standards), as well as the current and potential onsite and offsite uses and users of groundwater for drinking and other purposes. As discussed in Section 3.6.4.1.1, low-level liquid radioactive waste effluent from PTN is also discharged by procedurally controlled processes to the IWW facility (CCS). Groundwater tritium levels ranging from non-detectable to 5,500 pCi/L were detected in on-site well PTN-MW-5s in the first quarter of 2016, as shown in Table 4.5-1. This tritium concentration decreased to 480 pCi/L by the fourth quarter of 2016. (PTN 2017b) Since the groundwater monitoring program was initiated in 2010, no plant-related gamma isotopes or hard-to-detect radionuclides have been detected. Therefore, due to continued operations within the requirements of established operating procedures, permits, and site monitoring programs, FPL concludes that impacts from radionuclides to groundwater are SMALL and do not warrant additional mitigation measures beyond PTN's existing groundwater monitoring program and administrative controls.

Table 4.5-1
Turkey Point Groundwater Monitoring Results, Tritium Activity Concentration (pCi/L), 2016 (Sheet 1 of 2)

Well	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
PTPED-1	488	< MDC	< MDC	320
CD-1	545	751	481	< MDC
P-94-2	2,010	N/A	386	N/A
P-94-4	2,200	1,310	1,170	903
STP-1	< MDC	N/A	< MDC	N/A
PTN-MW-1S	< MDC	N/A	< MDC	N/A
PTN-MW-1I	700	N/A	380	N/A
PTN-MW-1D	1,760	N/A	1,950	N/A
PTN-MW-2S	< MDC	N/A	< MDC	N/A
PTN-MW-3S	< MDC	N/A	< MDC	N/A
PTN-MW-4S	1,050	< MDC	343	< MDC
PTN-MW-4I	3,570	< MDC	< MDC	< MDC
PTN-MW-4D	< MDC	< MDC	3,720	< MDC
PTN-MW-5S	5,500	1,320	884	480
PTN-MW-5I	521	2,610	542	344
PTN-MW-5D	2,500	2,760	2,880	2,700
PTN-MW-6S	< MDC	N/A	< MDC	N/A
PTN-MW-6D	1,530	N/A	1,960	N/A
PTN-MW-7S	649	756	886	916
PTN-MW-7I	1,760	1,730	2,400	2,370
PTN-MW-7D	< MDC	< MDC	< MDC	< MDC
PTN-MW-8S	1,020	2,910	3,900	964
PTN-MW-9S	561	455	< MDC	422
PTN-MW-10S	< MDC	N/A	< MDC	N/A
PTN-MW-10I	1,290	N/A	< MDC	N/A

Table 4.5-1
Turkey Point Groundwater Monitoring Results, Tritium Activity Concentration (pCi/L), 2016 (Sheet 2 of 2)

Well	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
PTN-MW-10D	< MDC	N/A	< MDC	N/A
PTN-MW-11S	< MDC	< MDC	< MDC	< MDC
PTN-MW-12S	1,140	1,080	1,040	868

(PTN 2017b)

N/A = Not applicable, sampling not required for this quarter.

< MDC = Value less than 3.00E+02 pCi/L for tritium.

4.6 Ecological Resources

The following sections address the ecological resource issues applicable to PTN, providing background on the issues and the analyses regarding the SLR period.

4.6.1 Impingement and Entrainment of Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds)

4.6.1.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL, MODERATE, or LARGE. The impacts of impingement and entrainment are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems, depending on cooling system withdrawal rates and volumes and the aquatic resources at the site.

4.6.1.2 Requirement [10 CFR 51.53(c)(3)(ii)(B)]

If the applicant's plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of current Clean Water Act 316(b) determinations or equivalent state permits and supporting documentation. If the applicant cannot provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from impingement and entrainment.

4.6.1.3 Background [GEIS Section 4.6.1.2]

Impingement occurs when organisms are held against the intake screen or netting placed within intake canals. Most impingement involves fish and shellfish. At some nuclear power plants, other vertebrate species may also be impinged on the traveling screens or on intake netting placed within intake canals.

Entrainment occurs when organisms pass through the intake screens and travel through the condenser cooling system. Aquatic organisms typically entrained include ichthyoplankton (fish eggs and larvae), larval stages of shellfish and other macroinvertebrates, zooplankton, and phytoplankton. Juveniles and adults of some species may also be entrained if they are small enough to pass through the intake screen openings, which are commonly 0.38 in. (1 cm) at the widest point.

The magnitude of the impact would depend on plant-specific characteristics of the cooling system (including location, intake velocities, screening technologies, and withdrawal rates) and characteristics of the aquatic resource (including population distribution, status, management objectives, and life history).

4.6.1.4 Analysis

As discussed in Section 2.2.3, PTN withdraws water from the CCS, which is not classified as waters of the U.S. by the EPA.

Entrainment of Fish and Shellfish in Early Life Stages

For plants with cooling ponds, including the Turkey Point CCS, entrainment of fish and shellfish in early life stages into cooling water systems associated with nuclear power plants is considered a Category 2 issue, requiring a site-specific assessment before license renewal. (NRC 2002a, Section 4.1.1)

The closed-loop, recirculating Turkey Point CCS neither withdraws nor discharges surface water to any surface water of the United States or the State of Florida. Therefore, impacts of entrainment on early life stages are limited to the CCS, and there are no impacts from entrainment of fish and shellfish in early life stages on biotic resources of Biscayne Bay, Card Sound, or other waters. (NRC 2002a, Section 4.1.1)

A species list or faunal survey for the fish and shellfish of the CCS is not available. Suitable spawning habitat for game species that favor ocean passes or open bays, such as the common snook and tarpon, is not present in the CCS. Table 3.7-1 details fish species historically documented as occurring in the CCS. As reported in the 2002 PTN EIS, game fish numbers in the CCS declined to very low numbers due to lack of spawning habitat. The 2002 EIS states that the predominant fish in the canals are killifish and other live-bearers. (NRC 2002a, Section 4.1.1) The absence of any hydrological connection between the CCS and adjacent waters prevents the establishment of new fish and shellfish populations in the CCS. Therefore, it is reasonable to conclude that killifish and live-bearers remain the dominant fish species in these waters.

Based on this review, the potential impacts of the cooling-water-intake system's entrainment of fish and shellfish in early life stages are SMALL, and mitigation is not warranted.

Impingement of Fish and Shellfish

For plants with once-through cooling systems, including the Turkey Point CCS, impacts of fish and shellfish on debris screens of cooling-water systems associated with nuclear power plants is considered a Category 2 issue, requiring a site-specific assessment before license renewal. (NRC 2002a, Section 4.1.2)

The closed-loop, recirculating Turkey Point CCS neither withdraws nor discharges surface water to the waters of the State. Therefore, impacts from impingement of fish and shellfish are limited to fish and shellfish in the cooling canals, and there are no impacts from impingement on fish and shellfish of Biscayne Bay, Card Sound, or other waters. (NRC 2002a, Section 4.1.2)

Impacts from impingement of fish and shellfish are limited to the populations of fish and shellfish residing in the CCS. A species list or faunal survey for the fish and shellfish of the CCS is not available.· Suitable spawning habitat for game species that favor ocean passes or open bays, such as the common snook and tarpon, is unlikely to occur in the CCS, although the 2002 PTN EIS reported that some gamefish spawning in the canals may still be occurring at that time. The 2002 EIS states that the dominant fish species in the CCS are killifish and other live-bearers (NRC 2002a, Section 4.1.2). The absence of any hydrological connection between the CCS and adjacent waters prevents the establishment of new fish and shellfish populations in the CCS. Therefore, it is unlikely that species not documented in the previous EIS are present in the CCS, and killifish and live-bearers likely remain the dominant fish species in these waters. The preferred habitat for killifish and other live-bearers are shallows and aquatic vegetation, and individuals are not widely ranging. It is unlikely that populations of such species would be greatly affected by impingement in the intakes of the nuclear plants. Any impacts on fish and shellfish populations within the CCS from impingement would not impact recreational or commercial fishing, because the cooling canals are closed to fishing or other resource-based uses. (NRC 2002a, Section 4.1.2)

Based on the available information relative to potential impacts of the cooling water intake system on the impingement of fish and shellfish, the potential impacts are SMALL, and mitigation is not warranted.

4.6.2 Thermal Impacts on Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds)

4.6.2.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL, MODERATE, or LARGE. Most of the effects associated with thermal discharges are localized and are not expected to affect overall stability of populations or resources. The magnitude of impacts, however, would depend on site-specific thermal plume characteristics and the nature of aquatic resources in the area.

4.6.2.2 Requirement [10 CFR 51.53(c)(3)(ii)(B)]

If the applicant's plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of a 316(a) variance in accordance with 40 CFR Part 125, or equivalent state permits and supporting documentation. If the applicant cannot provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from thermal changes

4.6.2.3 Background [GEIS Section 4.6.1.2]

Because characteristics of both the thermal discharges and the affected aquatic resources are specific to each site, NRC classified heat shock as a Category 2 issue that required a site-specific assessment for license renewal. The NRC found the potential for thermal discharge impacts to be greatest at plants with once-through cooling systems, primarily because of the higher discharge temperatures and larger thermal plume area compared to plants with cooling towers.

The impact level at any plant depends on the characteristics of its cooling system (including location and type of discharge structure, discharge velocity and volume, and three-dimensional characteristics of the thermal plume) and characteristics of the affected aquatic resources (including the species present and their physiology, habitat, population distribution, status, management objectives, and life history).

4.6.2.4 Analysis

PTN discharges to the CCS, which is not classified as waters of the U.S. by the EPA and is therefore not subject to CWA jurisdiction, and not subject to 316(a) regulations.

However, site conditions of certification require temperature monitoring in the canals and Biscayne Bay. The Fifth Supplemental Agreement requires monitoring of temperature in the canal system and adjacent surface and groundwater and ecological impacts from the canals. This information is reported annually, per the conditions of the Fifth Supplemental Agreement. (SFWMD 2009)

The 2002 LRA for PTN determined that use of the CCS would not result in thermal impacts to adjacent Waters of the U.S., including Biscayne Bay and Card Sound (NRC 2002a). However, the PTN uprate was anticipated to result in a temperature increase in the CCS. The Fifth Supplemental Agreement, authorizing the uprate, mandates temperature monitoring in the CCS and the adjacent Card Sound and Biscayne Bay, to ensure that there are no thermal impacts to waters of the U.S. A minimum of 2 years of monitoring was required prior to the uprate (SFWMD 2009). Pre-uprate monitoring data were collected prior to February 26, 2012; interim operating data were collected between February 26, 2012, and May 27, 2013; and post-uprate monitoring began after May 27, 2013.

Post-uprate monitoring did detect an increase in temperature in the CCS. The post-uprate temperatures near the plant discharge into the CCS and near the plant intake were 4.5ºC and 3.2ºC warmer, respectively, than the pre-uprate period. While pre- and post-uprate averages may not be directly comparable because they do not cover the same number of months, the post-uprate water temperatures were consistently warmer. The increase in CCS surface water temperatures during the post-uprate period cannot be explained by the uprate, because the total heat rejection rate to the CCS from Turkey Point Units 1, 2, 3, and 4, operating at full capacity prior to the uprate monitoring period, would have been higher than the post-uprate heat rejection rate to the CCS for Units 1, 3, and 4 operating at full capacity. Unit 2 was dedicated to operate in a synchronous condenser mode (i.e., not producing steam heat) in the beginning of 2011, thereby requiring no heat rejection from the CCS. FPL's observations have concluded that the temporal increase in average CCS temperature in 2014 (during the post-uprate monitoring period) was the result of a series of events that degraded CCS water quality and negatively affected the heat exchange capacity of the CCS, including the following: lower than average precipitation into the CCS during 2011 through early 2014; reduced circulation within the CCS; periods of degraded water quality in the CCS during 2012 and 2013 (increased salinity, turbidity, and algal concentration); and decreased CCS heat exchange efficiency from historical levels in 2013 and 2014, likely due to significant blockages and increased sediment levels principally in the northern segments of the CCS.

There continue to be no discernable effects of the CCS on Biscayne Bay surface water quality at monitoring stations located out in the bay. For most surface water stations around the CCS, there was no readily apparent change in the influence of CCS water via the groundwater pathway during the post-uprate period, as compared to the pre-uprate data. There were two locations in the surface water canal stations immediately adjacent to the southern end of the CCS (TPSWC-4, located in the S-20 Canal, and TPSWC-5, located in the Card Sound Canal) where there appeared to be some CCS water present/influence during the pre- and post-uprate monitoring periods. Regardless, water quality and tritium data collected during the pre- and post-uprate monitoring period at TPBBSW-4, located at the mouth of the S-20 Canal and Card Sound Canal in Biscayne Bay, did not show evidence of CCS water. This indicates influence immediately adjacent to the CCS but minimal, if any, influence in Biscayne Bay.

In conclusion, while temperature has increased in the CCS, this aquatic feature is not a water of the U.S. and is not subject to CWA 316(a) regulations. Ongoing field studies indicate that thermal dynamics in the CCS do not influence Biscayne Bay or Card Sound, and therefore, impacts are anticipated to be SMALL, and mitigation measures are not warranted.

4.6.3 Water Use Conflicts with Aquatic Resources (Plants with Cooling Ponds or Cooling Towers Using Makeup Water from a River)

4.6.3.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL or MODERATE. Impacts on aquatic resources in stream communities affected by water use conflicts could be of moderate significance in some situations.

4.6.3.2 Requirement [10 CFR 51.53(c)(3)(ii)(A)]

If the applicant's plant utilizes cooling towers or cooling ponds and withdraws makeup water from a river, an assessment of the impact of the proposed action on water availability and competing water demands, the flow of the river, and related impacts on stream (aquatic) ecological communities must be provided.

4.6.3.3 Background [GEIS Section 4.6.1.2]

Increased temperatures and/or decreased rainfall would result in lower river flows, increased cooling pond evaporation, and lowered water levels in the Great Lakes or reservoirs. Regardless of overall climate change, droughts could result in problems with water supplies and allocations.

Because future agricultural, municipal, and industrial users would continue to share their demands for surface water with power plants, conflicts might arise if the availability of this resource decreased.

Water use conflicts with aquatic resources could occur when water to support these resources is diminished either because of decreased water availability due to droughts; increased demand for agricultural, municipal, or industrial usage; or due to a combination of such factors. Water use conflicts with biological resources in stream communities are a concern due to the duration of license renewal and potentially increasing demands on surface water.

4.6.3.4 Analysis

As discussed in Sections 2.2.3.2, 4.5.1.4, and 4.5.2.4, PTN does not obtain makeup water from a river. Therefore, this issue is not applicable, and further analysis is not required.

4.6.4 Water Use Conflicts with Terrestrial Resources (Plants with Cooling Ponds or Cooling Towers Using Makeup Water from a River)

4.6.4.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL or MODERATE. Impacts on terrestrial resources in riparian communities affected by water use conflicts could be of moderate significance.

4.6.4.2 Requirement [10 CFR 51.53(c)(3)(ii)(A)]

If the applicant's plant utilizes cooling towers or cooling ponds and withdraws makeup water from a river, an assessment of the impact of the proposed action on water availability and competing water demands, the flow of the river, and related impacts on . . . riparian (terrestrial) ecological communities must be provided.

4.6.4.3 Background [GEIS Section 4.6.1.1]

Water use conflicts with terrestrial resources in riparian communities could occur when water that supports these resources is diminished either because of decreased availability due to droughts; increased water demand for agricultural, municipal, or industrial usage; or a combination of such factors. For future license renewals, the potential range of impact levels at plants with cooling ponds or cooling towers using makeup water from a river cannot be determined at this time.

4.6.4.4 Analysis

As discussed in Sections 2.2.3.2, 4.5.1.4, and 4.5.2.4, PTN does not obtain makeup water from a river. Therefore, this issue is not applicable, and further analysis is not required.

4.6.5 Effects on Terrestrial Resources (Non-Cooling System Impacts)

4.6.5.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL, MODERATE, or LARGE. Impacts resulting from continued operations and refurbishment associated with license renewal may affect terrestrial communities. Application of BMPs would reduce the potential for impacts. The magnitude of impacts would depend on the nature of the activity, the status of the resources that could be affected, and the effectiveness of mitigation.

4.6.5.2 Requirement [10 CFR 51.53(c)(3)(ii)(E)]

All license renewal applicants shall assess the impact of refurbishment, continued operations, and other license-renewal-related construction activities on important plant and animal habitats.

4.6.5.3 Background [GEIS Section 4.6.1.1]

Continued operations and refurbishment activities could continue to affect onsite terrestrial resources during the license renewal term at all operating nuclear power plants. Factors that could potentially result in impacts include landscape maintenance activities, stormwater management, and elevated noise levels. These impacts would, for the most part, be similar to past and ongoing impacts.

The characteristics of terrestrial habitats and wildlife communities currently on nuclear power plant sites have generally developed in response to many years of typical operations and maintenance programs. While some may have reached a relatively stable condition, some habitats and populations of some species may have continued to change gradually over time. Operations and maintenance activities during the license renewal term are expected to be similar to current activities. Because the species and habitats present on the sites (i.e., weedy species and habitats they make up) are generally tolerant of disturbance, it is expected that continued operations during the license renewal term would maintain these habitats and wildlife communities in their current state, or maintain current trends of change.

Terrestrial habitats and wildlife could be affected by ground disturbance from refurbishment-related construction activities. Land disturbed during the construction of new ISFSIs would range from about 2.5 to 10 ac (1 to 4 ha). Other activities may include new parking areas for plant employees, access roads, buildings, and facilities. Temporary project support areas for equipment storage, worker parking, and material laydown areas could also result in the disturbance of habitat and wildlife.

Successful application of environmental review procedures, employed by the licensees at many of the operating nuclear plant sites, would result in the identification and avoidance of important terrestrial habitats. In addition, the application of BMPs to minimize the area affected; to control fugitive dust, runoff, and erosion from project sites; to reduce the spread of invasive nonnative plant species; and to reduce disturbance of wildlife in adjacent habitats could greatly reduce the impacts of continued operations and refurbishment activities.

4.6.5.4 Analysis

Refurbishment Activities

As discussed in Section 2.3, no license renewal-related refurbishment activities have been identified. Therefore, there would be no license renewal-related refurbishment impacts to important plant and animal habitats, and no further analysis is required.

Operational Activities

Terrestrial resources are described in Section 3.7.2. No license renewal-related construction activities or changes in operational practices have been identified that would involve disturbing habitats. FPL would continue to conduct ongoing plant operational and maintenance activities during the SLR period. However, these activities are expected to have minimal impacts on terrestrial resources because activities are anticipated to occur within previously disturbed habitats.

Operational and maintenance activities that FPL might undertake during the SLR term, such as maintenance and repair of plant infrastructure (e.g., roadways, piping installations, fencing, and other security infrastructure), would likely be confined to previously disturbed areas of the site. Furthermore, as discussed in Section 9.6, FPL has administrative controls in place at Turkey Point to ensure that operational changes or construction activities are reviewed, and the impacts minimized through implementation of BMPs, permit modifications, or acquisition of new permits as needed. In addition, regulatory programs that the site is currently subject to such as stormwater management, spill prevention, dredging, and herbicide usage further serve to minimize impacts to terrestrial resources.

In summary, adequate management programs and regulatory controls are in place to ensure that important plant and animal habitats are protected during the SLR period.

Therefore, FPL concludes the impacts to the terrestrial ecosystems from SLR are SMALL, and no additional mitigation measures beyond current management programs and existing regulatory controls are required.

4.6.6 Threatened, Endangered, and Protected Species, and Essential Fish Habitat

4.6.6.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

The magnitude of impacts on threatened, endangered, and protected species, critical habitat, and EFH would depend on the occurrence of listed species and habitats and the effects of power plant systems on them. Consultation with appropriate agencies would be needed to determine whether special status species or habitats are present and whether they would be adversely affected by continued operations and refurbishment associated with license renewal.

4.6.6.2 Requirement [10 CFR 51.53(c)(3)(ii)(E)]

All license renewal applicants shall assess the impact of refurbishment, continued operations, and other license renewal-related construction activities on important plant and animal habitats. Additionally, the applicant shall assess the impact of the proposed action on threatened or endangered species in accordance with federal laws protecting wildlife, including but not limited to, the ESA, and EFH in accordance with the MSA.

4.6.6.3 Background [GEIS Section 4.6.1.3]

There are several federal acts that provide protection to certain species and habitats that are treated here under a single issue. The issue includes impacts to biological resources such as threatened and endangered species and their critical habitat under the ESA, EFH as protected under the MSA, and impacts to mammalian species protected under the Marine Mammal Protection Act.

Factors that could potentially result in impacts on listed terrestrial species include habitat disturbance . . . operation and maintenance of cooling systems, transmission line ROW maintenance, collisions with . . . and transmission lines, and exposure to radionuclides. The listed species on or in the vicinity of nuclear power plants also range widely, depending on numerous factors such as the plant location and habitat types present.

Potential impacts of continued operations and refurbishment activities on federally or state-listed threatened and endangered species, protected marine mammals, and EFH could occur during the license renewal term. Factors that could potentially result in impacts to these species and habitats include impacts of refurbishment, other ground-disturbing activities, release of contaminants, effects of cooling water discharge on dissolved oxygen, gas supersaturation, eutrophication, thermal discharges, entrainment, impingement, reduction in water levels due to the cooling system operations, dredging, radionuclides, and transmission line ROW maintenance.

4.6.6.4 Analysis

Refurbishment Activities

As discussed in Section 2.3, no license renewal-related refurbishment activities have been identified. Therefore, there would be no license renewal-related refurbishment impacts to threatened, endangered, and protected species, or EFH, and no further analysis is required.

Operational Activities

As discussed in Section 3.7.8.1, there are 52 federally listed species which are either threatened, endangered, or candidate species within Miami-Dade County. In addition, as discussed in Section 3.7.8.2, the FFWCC has designated 118 plant and animal species as state-listed threatened or endangered, in addition to those that are also listed as endangered or threatened under the federal ESA.

Federally Listed Species

As discussed in Section 3.7.8.1, of the 52 federally listed species, 21 are plant species. No clearing activities are anticipated to occur as the result of continued operations of PTN. Therefore, impacts to federally listed plant species will not be considered further. Further, PTN does not discharge cooling water to Biscayne Bay, Card Sound, or other waters of the U.S. Therefore, the 10 federally listed species inhabiting these waters, including shortnose sturgeon (*Acipenser brevirostrum*), Atlantic sturgeon (*Acipenser oxyrhynchus oxyrhynchus*), Nassau grouper (*Epinephelus striatus*), smalltooth sawfish (*Pristis pectinate*), loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), leatherback sea turtle (*Dermochelys coriacea*), hawksbill sea turtle (*Eretmochelys imbricate*), Kemp's ridley sea turtle (*Lepidochlys kempii*), and the Florida manatee (*Trichechus manatu*), are excluded from analysis. While federally listed as occurring in Miami-Dade County, habitat associations for 11 species are so restricted, or species occurrences are so rare, that these species are unlikely to occur on the Turkey Point property. These species are Florida leafwing (*Anaea troglodyta floridalis*), Miami tiger beetle (*Cicindelidia floridana*), Miami blue butterfly (*Cyclargus thomasi bethunebakeri*), Schaus' swallowtail (*Papilio aristodemus ponceanus*), Bartram's scrub-hairstreak (*Strymon acis bartrami*), Stock Island tree snail (*Orthalicus reses reses*), gopher tortoise (*Gopherus Polyphemus*), Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*), Audubon's crested caracara (*Polyborus plancus audubonii*), Kirtland's warbler (*Setophaga kirtlandi*), and Bachman's warbler (*Vermivora bachmani*). These species are not included in this analysis based on the low likelihood of occurrence on the Turkey Point property.

Habitat for nine federally listed species may occur on or adjacent to the Turkey Point property: American alligator (*Alligator mississippiensis*), American crocodile (*Crocodylus acutus*), eastern indigo snake (*Drymarchon corais couperi*), rufa red knot (*Calidris canutus*), piping plover (*Charadrius melodus*), wood stork (*Mycteria americana*), snail kite (*Rostrhamus sociabili*), Florida bonneted bat (*Eumops floridanus*), and Florida panther (*Puma concolor coryi*).

As a requirement of the SCA and Fifth Supplemental Agreement, crocodiles on the site are monitored under FPL's crocodile management plan, which is focused on the creation of an environment and the enhancement of crocodile nesting habitat as well as the monitoring the reproductive success, growth, and survival of hatchlings. PTN is one of three nesting locations in Florida. While the number of successful nests located at the site has decreased in recent years, the American crocodile population continues to remain in a much stronger position than before the Turkey Point CCS was established. Today, crocodiles continue to migrate in and out of the

CCS and call the system home. Despite the environmental changes taking place within the CCS, in 2016 the American crocodiles had eight successful nests, and 127 hatchlings were released at Turkey Point outside of the CCS. Therefore, operation of PTN has positively affected this species. No increase in traffic volume is anticipated to result from the continued operation of PTN, and continued operation of PTN will not result in a loss of habitat. This species is therefore not likely to be adversely affected by continued operation of PTN.

American alligators have the potential to occur on the Turkey Point site. However, while alligators are tolerant to low salinity levels, they are typically more prevalent in fresh and brackish water with salinity levels less than 35 ppt (Fujisaki et al. 2014). Salinity concentrations in the CCS are approximately twice that of Biscayne Bay. (FPL 2014a, Section 2.3.3.1.2) and, therefore, likely too high for the canals to be considered suitable habitat for alligators. Therefore, occurrences of American alligators on the Turkey Point property are unlikely, and the continued operation of PTN is unlikely to affect this species.

Eastern indigo snakes rely on a matrix of habitats to survive, and movement among habitats that contain roads increases the potential for vehicle collision mortality. Snakes in general are prone to collision mortality, because they use road surfaces for thermoregulation and their shape, coloration, and low profile make them difficult for automobile drivers to see. However, increased automobile traffic is not anticipated to occur as a result of continued operation of PTN; therefore, the likelihood of mortality resulting from vehicle collisions is low. (NRC 2016a, Section 5.3.1.3) Continued operation of PTN will not result in a loss of habitat. This species is therefore not likely to be adversely affected by continued operation of PTN.

Piping plovers and red knots are shorebirds that use open habitats, such as beaches and mudflats, during winter in southern Florida. Both are small birds not known to be exceptionally prone to collision mortality, so the likelihood of collision with tall structures associated with PTN is expected to be minimal, as is collision with vehicles. (NRC 2016a, Section 5.3.1.3) Collisions with in-scope transmission lines are not anticipated because in-scope transmission lines are located in areas with no ecological value to these species. Continued operation of PTN will not result in a loss of habitat. This species is therefore not likely to be adversely affected by continued operation of PTN.

Wood storks occur in a variety of wetlands and have been observed foraging in shallow portions of the CCS. Water within the system is hypersaline, and the prey wood storks consume are adapted to this environment. However, wood storks have not been observed in great numbers within the CCS, and it is not believed to be a major foraging area. Although juvenile wood storks are not particularly adept at flying, the likelihood of avian collision with tall structures is expected to be minimal. Collisions with in-scope transmission lines are not anticipated because in-scope transmission lines are located in areas with no ecological value to these species. Continued operation of PTN will not result in a loss of habitat. Therefore, the continued operation of PTN is not expected to noticeably affect the wood stork population growth in the region. (NRC 2016a, Section 5.3.1.3)

As discussed in Section 3.7.8.1, migratory movements or local flight patterns may result in the occurrence of the snail kite on the site. Habitat for this species may be located on portions of the Turkey Point site. However, activities on the Turkey Point site are conducted within compliance standards of the MBTA. When necessary, consultation with responsible agencies is conducted to maintain compliance with existing regulations. Compliance with all regulatory requirements associated with this species will continue to be an administrative control practiced by FPL for the life of the PTN facility. Adherence to these controls, as well as compliance with laws and regulations, will prevent impacts to this species. Collisions with in-scope transmission lines are not anticipated because in-scope transmission lines are located in areas with no ecological value to these species. Continued operation of PTN will not result in a loss of habitat. The continued operation of PTN is not likely to adversely affect this species.

The Florida bonneted bat may be present on the Turkey Point property. The Turkey Point site does not contain cavity-bearing, mature trees, or other man-made structures that would provide roosting habitat for the bat. FPL's compliance with federal, state, and local laws and regulations will prevent impacts to this species. Continued operation of the PTN facility is not likely to affect this species.

The USFWS recognizes much of Miami-Dade County and southern Florida as a Florida panther focus area. Although the focus area excludes the Turkey Point site, lands immediately adjacent the Turkey Point site to the south and west are contained within the focus area and are also considered to be within the panther's primary zone. Florida panthers are susceptible to vehicle collisions; one in five deaths of or major injuries to radio-collared panthers resulted from a collision with a vehicle. However, no increase in traffic volume is anticipated to result from the continued operation of PTN. Therefore, an increased risk of collision with this species is not anticipated. Continued operation of PTN will not result in a loss of habitat. (NRC 2016a, Section 5.3.1.3) The continued operation of PTN is not likely to adversely affect this species.

State-Listed Species

A total of 104 plant species are listed by the State of Florida as occurring in Miami-Dade County (Table 3.7-15). Many occur in habitats not found on the Turkey Point site. Some of these plants, such as Small's flax (*Linum carteri var. smallii*) and the Bahama ladder brake (*Pteris bahamaensis*) are known to occur in disturbed habitat, and the banded wild-pine (*Tillandsia flexuosa*) is an epiphyte that grows on a variety of other plants that occur in a wide range of habitats. The range of habitats the state-listed plants represent indicates that some of the species could occur within the plant area on the Turkey Point site, but the extent of their occurrence is undetermined. However, because continued operation of PTN do not involve clearing activities, state-listed plant species on the Turkey Point property are not likely to be impacted by continued operation of PTN (NRC 2016a, Section 5.3.1.3).

As discussed in Section 3.7.8.2, suitable habitat for a total of 10 state-listed species is likely to occur on the Turkey Point property. The following species are likely to occur on the Turkey Point property: Florida burrowing owl (*Athene cunicularia floridana*), little blue heron (*Egretta caerulea*), reddish egret (*Egretta rufescens*), tricolored heron (*Egretta tricolor*), southeastern American kestrel (*Falco sparverius paulus*), American oystercatcher (*Haematopus palliatus*), white-crowned pigeon (*Patagioenas leucocephala*), roseate spoonbill (*Platalea ajaja*), black skimmer (*Rynchops niger*), least tern (*Sternula antillarum*), southern mink, Southern Florida Pop (*Neovison vison* pop. 1).

One Florida burrowing owl was observed in 2010 within the Turkey Point site CCS. Florida burrowing owls are found in open upland habitat and cleared areas. Although berms among the canals of the CCS could be considered to be potential habitat because they are mostly non-vegetated and the deposition of fill raised them to upland elevations, the occurrence of a single burrowing owl does not necessarily indicate habitat suitable for Florida burrowing owls is present within the CCS. If these berms were, in fact, suitable for burrowing owls, one would expect more than a single observation. Therefore, continued operation of PTN is unlikely to affect this species, because occurrences of this species are rare. (NRC 2016a, Section 5.3.1.3)

Little blue heron, reddish egret, tricolored heron, and roseate spoonbill are all piscivorous wading birds. They all have been observed on the Turkey Point site in shallow wetland habitats. Operational noise may displace some individuals, but their occurrence within suitable habitats despite the current operation of existing plants indicates most adapt to increased noise, activity, and artificial light levels. Continued operation of PTN is not expected to affect populations of these species. (NRC 2016a, Section 5.3.1.3)

The American oystercatcher occurs on large open expanses and forages in shellfish beds. No known shellfish beds would be affected by the continued operation of PTN. Other operational effects, including noise and artificial lighting, are not expected to affect American oystercatchers. (NRC 2016a, Section 5.3.1.3)

As discussed in Section 3.7.8.2, migratory movements or local flight patterns may result in the occurrence of the southeastern American kestrel to the site. Habitat for this species may be located on portions of the Turkey Point site. However, activities on the Turkey Point site are evaluated to ensure compliance under the MBTA. When necessary, consultation with responsible agencies is conducted to maintain compliance with existing regulations. Compliance with all regulatory requirements associated with this species will continue to be an administrative control practiced by FPL for the life of the Turkey Point facility. Adherence to these controls, as well as compliance with laws and regulations, will prevent impacts to this species. The continued operation of PTN is not likely to impact this species.

White-crowned pigeons forage on fruit-bearing trees, especially poisonwood (*Metopium toxiferum*), located north and west of the CCS. Operational noise may displace some individuals, but their occurrence within suitable habitats despite the operation of existing plants indicates most adapt to increased noise, activity, and artificial light levels. Continued operation of PTN is not expected to affect populations of these species. (NRC 2016a, Section 5.3.1.3)

Black skimmers and least terns forage over open water. Least terns have been observed on the Turkey Point site, and dredge spoil may provide suitable nesting habitat for both species. Operational noise may displace skimmers and terns from dredge spoil within the CCS. (NRC 2016a, Section 5.3.1.3)

The Everglades mink may potentially use wetlands within the Turkey Point site. Little is known about the Everglades mink but, as with other species, operational noise may deter mink from using parts of the site nearby the facilities. Mink are primarily active at night. The effects of artificial lighting on mink are not known (NRC 2016a, Section 5.3.1.3). However, the effects of continued operation of PTN does not include refurbishment activities and, therefore, would not alter availability or suitability of wetland habitats for the Everglades mink.

FPL is not aware of any adverse impacts regarding threatened, endangered, and protected species attributable to the site. Maintenance activities necessary to support SLR likely would be limited to previously disturbed areas on site, and no additional land disturbance has been identified for the purpose of SLR. In addition, there are no plans to alter plant operations during the SLR term which would affect threatened, endangered, and protected species. FPL would be required to comply with all applicable federal, state, and local laws, regulations, and permitting requirements to minimize potential impacts on listed species. If operational impacts on state-listed wildlife cannot be avoided, FPL would be required to coordinate with the USFWS and the FFWCC on the need for appropriate mitigation.

As discussed in Section 9.6, FPL has administrative controls in place at Turkey Point to ensure that operational changes or construction activities are reviewed, and the impacts minimized through implementation of BMPs. In addition, regulatory programs, such as those discussed in Chapter 9 that the site is subject to further serve to minimize impacts to any threatened, endangered, and protected species.

In an effort to obtain an independent review, the USFWS and NMFS were also consulted. Based on this independent review, it was determined that there would be no effect on federally and state-listed threatened, endangered, and protected species or on designated critical habitat as a result of PTN SLR. In addition, NMFS concluded no designated EFH would be impacted by continued operation of PTN. Copies of the consultation letters to the USFWS and NMFS are included in Attachment B.

In summary, no license renewal-related refurbishment activities have been identified. As discussed above, the continued operation of PTN would have no adverse effect on any federally or state-listed species. Therefore, FPL concludes that SLR would have no effect on threatened, endangered, and protected species in the vicinity of Turkey Point, and mitigation measures beyond FPL current management programs and existing regulatory controls are not warranted.

4.7 Historic and Cultural Resources

The following sections address the historic and cultural resource issues applicable to PTN, providing background on the issues and the analyses regarding the SLR period.

4.7.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

Continued operations and refurbishment associated with license renewal are expected to have no more than small impacts on historic and cultural resources located onsite and in the transmission line ROW because most impacts could be mitigated by avoiding those resources. The NHPA requires the federal agency to consult with the SHPO and appropriate Native American tribes to determine the potential effects on historic properties and mitigation, if necessary.

4.7.2 Requirement [10 CFR 51.53(c)(3)(ii)(K)]

All applicants shall identify any potentially affected historic or archaeological properties and assess whether any of these properties will be affected by future plant operations and any planned refurbishment activities in accordance with the NHPA.

4.7.3 Background [GEIS Section 4.7.1]

The NRC will identify historic and cultural resources within a defined APE. The license renewal APE is the area that may be impacted by land-disturbing or other operational activities associated with continued plant operations and maintenance during the license renewal term and/or refurbishment. The APE typically encompasses the nuclear power plant site, its immediate environs, including viewshed, and the transmission lines within this scope of review. The APE may extend beyond the nuclear plant site and transmission lines when these activities may affect historic and cultural resources.

Continued operations during the license renewal term and refurbishment activities at a nuclear power plant can affect historic and cultural resources through (1) ground-disturbing activities associated with plant operations and ongoing maintenance (e.g., construction of new parking lots or buildings), landscaping, agricultural or other use of plant property; (2) activities associated with transmission line maintenance (e.g., maintenance of access roads or removal of danger trees); and (3) changes to the appearance of nuclear power plants and transmission lines. Licensee renewal environmental reviews have shown that the appearance of nuclear power plants and transmission lines has not changed significantly over time; therefore additional viewshed impacts to historic and cultural resources are not anticipated.

4.7.4 Analysis

4.7.4.1 Refurbishment Activities

As discussed in Section 2.3, no license renewal-related refurbishment activities have been identified. Therefore, there would be no license renewal-related refurbishment impacts to historic and cultural resources, and no further analysis is required.

4.7.4.2 Operational Activities

As discussed in Section 3.7.2.2, Turkey Point property contains 7,996 acres of wetland, lake, and riverine waters (approximately 85 percent of the Turkey Point property). As discussed in Section 3.8.5, there have been seven previous cultural resource investigations conducted on the Turkey Point property. There are no recorded cultural resources on the 9,460-acre Turkey Point property, and there are no NRHP-listed resources within a 6-mile radius of Turkey Point.

As discussed in Section 3.8.6, although no license renewal-related ground-disturbing activities have been identified, FPL has administrative controls in place for management of cultural resources ahead of any future ground-disturbing activities at the plant. These consist of the 2016 conditions of certification and the Environmental Control Program for PTN. Therefore, no adverse effects are anticipated during the SLR term.

The area within a 2-mile radius of the site, especially along Biscayne Bay, may be archaeologically sensitive based on the location of archaeological sites in areas that have been surveyed for cultural resources (Table 3.8-1). However, adverse impacts would only occur to such sites as a result of soil-intrusive activities. Because FPL has no plans to conduct such soil-intrusive activities at any location outside of the Turkey Point property boundary under an SLR, no adverse effects to these archaeological sites would occur.

There are also no NRHP-listed aboveground historic properties within a 6-mile radius of PTN. As such, no potential adverse effects to any NRHP-listed properties, including viewshed, aesthetic, and noise impacts, as a result of the continued operation of PTN are expected. Two sites (Table 3.8-2) are eligible for the NRHP based on SHPO review, but based on the vegetation, topography, and distance, Turkey Point is not within the viewshed of these cultural resources. Due to no refurbishment activities being associated with the SLR, including construction and ground disturbances, no adverse effects to the NRHP-eligible resources are expected.

As discussed above, no license renewal-related refurbishment or construction activities have been identified. No offsite NRHP-listed historic properties will be adversely impacted as a result of continued operation of PTN, and there are no plans to alter operations, expand existing facilities, or disturb additional land for the purpose of SLR. As described in Section 3.8, the Florida SHPO/DHR, and Native American groups recognized as potential stakeholders, have been notified by FPL of the proposed action (Attachment C).

Therefore, FPL concludes that there will be no adverse effects as a result of continued operation of PTN during the SLR period, and additional mitigation measures beyond FPL's existing procedural administrative controls are not warranted.

4.8 Socioeconomics

The following sections address the socioeconomic issues applicable to PTN, providing background on the issues and the analyses regarding the SLR period.

4.8.1 Employment and Income, Recreation and Tourism

4.8.1.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL. Although most nuclear plants have large numbers of employees with higher than average wages and salaries, employment, income, recreation, and tourism impacts from continued operations and refurbishment associated with license renewal are expected to be small.

4.8.1.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.8.1.3 Background [GEIS Section 4.8.1.1]

Employees receive income from the nuclear power plant in the form of wages, salaries, and benefits. Employees and their families, in turn, spend this income on goods and services within the community thereby creating additional opportunities for employment and income. In addition, people and businesses in the community receive income for the goods and services sold to the power plant. Payments for these goods and services create additional employment and income opportunities in the community. The measure of a communities' ability to support the operational demands of a power plant depends on the ability of the community to respond to changing socioeconomic conditions.

Some communities experience seasonal transient population growth due to local tourism and recreational activities. Income from tourism and recreational activities creates employment and income opportunities in the communities around nuclear power plants.

Nevertheless, the effects of nuclear power plant operations on employment, income, recreation, and tourism are ongoing and have become well established during the current license term for all nuclear power plants. The impacts from power plant operations during the license renewal term on employment and income in the region around each nuclear power plant are not expected to change from what is currently being experienced. In addition, tourism and recreational activities in the vicinity of nuclear plants are not expected to change as a result of license renewal.

4.8.1.4 Analysis

Information related to employment and income, and recreational facilities is presented in Sections 3.9.1 and 3.9.7. No license renewal-related refurbishment activities have been identified as discussed in Section 2.3. In addition, as discussed in Section 2.5, there are no plans to add workers to support plant operations during the SLR period. As previously discussed in Section 3.2.3, there is sufficient vegetation and distance to screen the existing units from most areas. As a result, the site does not visually impact most local areas that have a high degree of visitor or recreational use. Therefore, no changes in employment and income, and recreation and tourism during the SLR period are anticipated.

In the GEIS, the NRC determined that employment and income, and recreation and tourism impacts from continued plant operations over the license renewal term would be SMALL for all nuclear plants, and designated this as a Category 1 issue (NRC 2013a, Section 4.8.1.1). Based on FPL's review, no new and significant information was identified as it relates to employment and income, and recreation and tourism, and further analysis is not required.

4.8.2 Tax Revenues

4.8.2.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL. Nuclear plants provide tax revenue to local jurisdictions in the form of property tax payments, payments in lieu of tax (PILOT), or tax payments on energy production. The amount of tax revenue paid during the license renewal term as a result of continued operations and refurbishment associated with license renewal is not expected to change.

4.8.2.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.8.2.3 Background [GEIS Section 4.8.1.2]

Nuclear power plants and the workers who operate them are an important source of tax revenue for many local governments and public school systems. Tax revenues from nuclear power plants mostly come from property tax payments or other forms of payments such as payments in lieu of (property) taxes, or PILOT payments, although taxes on energy production have also been collected from a number of nuclear power plants. County and municipal governments and public school districts receive tax revenue either directly or indirectly through state tax and revenue-sharing programs.

Counties and municipal governments in the vicinity of a nuclear power plant also receive tax revenue from sales taxes and fees from the power plant and its employees. Changes in the number of workers and the amount of taxes paid to county, municipal governments, and public schools can affect socioeconomic conditions in the counties and communities around the nuclear power plant.

A review of LRAs received by the NRC since the 1996 GEIS has shown that refurbishment activities, such as steam generator and vessel head replacement, have not had a noticeable effect on the assessed value of nuclear plants, thus changes in tax revenues are not anticipated from future refurbishment activities.

The primary impact of license renewal would be the continuation or change in the amount of taxes paid by nuclear power plant owners to local governments and public school systems. The impact of nuclear plant operations on tax revenues in local communities and the impact that the expenditure of tax revenues has on the region are not expected to change appreciably from the amount of taxes paid during the current license term. Tax payments during the license renewal term would be similar to those currently being paid by each nuclear plant.

4.8.2.4 Analysis

Information related to tax revenues is presented in Section 3.9.5. No license renewal-related refurbishment activities have been identified as discussed in Section 2.3. FPL's annual property taxes are expected to remain relatively constant through the SLR period.

In the GEIS, the NRC determined that tax revenue impacts from continued plant operations over the license renewal term would be SMALL for all nuclear plants, and designated this as a Category 1 issue (NRC 2013a, Section 4.8.1.2). Based on FPL's review, no new and significant information was identified as it relates to tax revenues, and further analysis is not required.

4.8.3 Community Services and Education

4.8.3.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL. Changes resulting from continued operations and refurbishment associated with license renewal to local community and educational services would be small. With little or no change in employment at the licensee's plant, value of the power plant, payments on energy production, and PILOT payments expected during the license renewal term, community and educational services would not be affected by continued power plant operations.

4.8.3.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.8.3.3 Background [GEIS Section 4.8.1.3]

Any changes in the number of workers at a nuclear plant will affect the demand for public services from local communities. Environmental reviews conducted by NRC since the 1996 GEIS have shown, however, that the number of workers at relicensed nuclear plants has not changed significantly because of license renewal, so demand-related impacts on community services, including public utilities, are no longer anticipated from future license renewals.

In addition, refurbishment activities, such as steam generator and vessel head replacement, have not required the large numbers of workers and the months of time that were conservatively analyzed in the 1996 GEIS, so significant impacts on community services are no longer anticipated. Because of the relatively short duration of refurbishment-related activities, workers are not expected to bring families and school-age children with them; therefore, impacts from refurbishment on educational services are also no longer anticipated.

Taxes paid by nuclear power plant owners support a range of community services, including public water, safety, fire protection, health, and judicial, social, and educational services. In some communities, tax revenues from power plants can have a noticeable impact on the quality of services available to local residents. Although many of the community services paid for by tax revenues from power plants are used by plant workers and their families, the impact of nuclear plant operations on the availability and quality of community services and education is SMALL and is not expected to change as a result of license renewal.

4.8.3.4 Analysis

Information related to community services and education is presented in Section 3.9.4. No license renewal-related refurbishment activities have been identified as discussed in Section 2.3. In addition, as discussed in Section 2.5, there are no plans to add workers to support plant operations during the SLR period. As discussed in Section 4.8.2.4, FPL's annual property taxes are expected to remain relatively constant through the SLR period.

In the GEIS, the NRC determined that community services and education impacts from continued plant operations over the license renewal term would be SMALL for all nuclear plants, and designated this as a Category 1 issue (NRC 2013a, Section 4.8.1.3). Based on FPL's review, no new and significant information was identified as it relates to community services and education, and further analysis is not required.

4.8.4 Population and Housing

4.8.4.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL. Changes resulting from continued operations and refurbishment associated with license renewal to regional population and housing availability and value would be small. With little or no change in employment at the licensee's plant expected during the license renewal term, population and housing availability and values would not be affected by continued power plant operations.

4.8.4.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.8.4.3 Background [GEIS Section 4.8.1.4]

Socioeconomic impact analyses of resources (e.g., housing) affected by changes in regional population are based on employment trends at nuclear power plants. Population growth from increased employment and spending at a nuclear power plant is important because it is one of the main drivers of socioeconomic impacts. As previously discussed, however, employment levels at nuclear power plants are expected to remain relatively constant with little or no population growth or increased demand for permanent housing during the license renewal term. The operational effects on population and housing values and availability in the vicinity of nuclear power plants are not expected to change from what is currently being experienced, and no demand-related impacts are expected during the license renewal term.

The increased number of workers at nuclear power plants during regularly scheduled plant refueling and maintenance outages does create a short-term increase in the demand for temporary (rental) housing units in the region around each plant. However, because of the short duration and the repeated nature of these scheduled outages and the general availability of rental housing units (including portable trailers) in the vicinity of nuclear power plants, employment-related housing impacts have had little or no long-term impact on the price and availability of rental housing. Refurbishment impacts would be similar to what is experienced during routine plant refueling and maintenance outages.

4.8.4.4 Analysis

Information related to population and housing is presented in Section 3.9.2. No license renewal-related refurbishment activities have been identified as discussed in Section 2.3. In addition, as discussed in Section 2.5, there are no plans to add workers to support plant operations during the SLR period.

In the GEIS, the NRC determined that population and housing impacts from continued plant operations over the license renewal term would be SMALL for all nuclear plants, and designated this as a Category 1 issue (NRC 2013a, Section 4.8.1.4). Based on FPL's review, no new and significant information was identified as it relates to population and housing, and further analysis is not required.

4.8.5 Transportation

4.8.5.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL. Changes resulting from continued operations and refurbishment associated with license renewal to traffic volumes would be small.

4.8.5.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.8.5.3 Background [GEIS Section 4.8.1.5]

Transportation impacts depend on the size of the workforce, the capacity of the local road network, traffic patterns, and the availability of alternate commuting routes to and from the plant. Because most sites have only a single access road, there is often congestion on these roads during shift changes.

Transportation impacts are ongoing and have become well established during the current licensing term for all nuclear power plants. As previously discussed, it is unlikely that the number of permanent operations workers would increase at a nuclear power plant during the license renewal term. In addition, refurbishment activities, such as steam generator and vessel head replacement, have not required the numbers of workers and the months of time conservatively estimated in the 1996 GEIS. Consequently, employment at nuclear power plants during the license renewal term is expected to remain unchanged.

4.8.5.4 Analysis

Information related to transportation is presented in Section 3.9.6. No license renewal-related refurbishment activities have been identified as discussed in Section 2.3. As discussed in Section 2.5, there are no plans to add workers to support plant operations during the SLR period. In addition, as discussed in Section 3.9.6, roads in the immediate vicinity of the Turkey Point plant site are anticipated to operate at acceptable levels.

In the GEIS, the NRC determined that transportation impacts from continued plant operations over the license renewal term would be SMALL for all nuclear plants, and designated this as a Category 1 issue (NRC 2013a, Section 4.8.1.5). Based on FPL's review, no new and significant information was identified as it relates to transportation, and further analysis is not required.

4.9 Human Health

The following sections address the human health issues applicable to PTN, providing background on the issues and the analyses regarding the SLR period.

4.9.1 Microbiological Hazards to the Public (Plants with Cooling Ponds or Canals, or Cooling Towers that Discharge to a River)

4.9.1.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL, MODERATE, or LARGE. These organisms are not expected to be a problem at most operating plants except possibly at plants using cooling ponds, lakes, or canals, or that discharge into rivers. Impacts would depend on site-specific characteristics.

4.9.1.2 Requirement [10 CFR 51.53(c)(3)(ii)(G)]

If the applicant's plant uses a cooling pond, lake, or canal or discharges into a river, an assessment of the impact of the proposed action on public health from thermophilic organisms in the affected water must be provided.

4.9.1.3 Background [GEIS Section 4.9.1.1.3]

N. fowleri, which is the pathogenic strain of the free-living amoebae *Naegleria* spp., appears to be the most likely microorganism that may pose a public health hazard resulting from nuclear power plant operations. Increased populations of *N. fowleri* may have significant adverse impacts.

Because *Naegleria* concentrations in fresh water can be enhanced by thermal effluents, nuclear power plants that use cooling lakes, canals, ponds, or rivers experiencing low-flow conditions may enhance the populations of naturally occurring thermophilic organisms.

Changes in microbial populations and in the public use of water bodies might occur after the OL is issued and the application for license renewal is filed. Other factors could also change, including the average temperature of the water, which could result from climate change that affected water levels and air temperature. Finally, the long-term presence of a power plant might change the natural dynamics of harmful microorganisms within a body of water.

4.9.1.4 Analysis

As discussed in Section 3.10, PTN discharges to the cooling canals, which are owner-controlled and closed to the public. The cooling canals do not discharge to surface waters, and thus the heated water does not have a pathway to enhance the naturally occurring thermophilic organisms within surface water accessible to the public. Also, as discussed in Section 3.10, the salinity concentration of the cooling canals anticipated for the SLR term is an annual average of 34 PSU, which is similar to ocean water and exceeds the freshwater conditions needed for the pathogen, *N. fowleri,* survival. PTN discharges to a 168-mile closed-loop CCS that occupies approximately 5,900 acres. The CCS receives heated effluent from the plant and distributes the flow into 32 feeder canals. The feeder canals discharge into a single collector canal that distributes the water into six return canals. (FPL 2000b, Section 3.1.2) As discussed in

Section 2.2.3.2, the Turkey Point NPDES permit authorizes discharges from the CCS into Class G-III groundwater, which is part of the surficial aquifer system. The permit does not authorize direct discharges to surface waters of the state.

While the cooling canals are closed to the public, FPL workers and contractors do perform work within the canals and thus could be exposed to *N. fowleri* or Legionella spp. The infection route for *N. fowleri* is water or water droplets being introduced into the nasal cavity, and for Legionella spp. the infection route is through inhalation. As discussed in Section 3.10, there are no water sprayers associated with the cooling canals, and work within the canals would be conducted under an occupational safety program.

Given the lack of an exposure pathway between the cooling canals and the public, the non-freshwater condition of the cooling canals, and the conditions and restrictions for the cooling canals minimizing exposure routes, the microbiological hazards to the public during the SLR term would be small, and no mitigation is warranted.

4.9.2 Electric Shock Hazards

4.9.2.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL, MODERATE, or LARGE. Electrical shock potential is of small significance for transmission lines that are operated in adherence with the NESC. Without a review of conformance with NESC criteria of each nuclear power plant's in-scope transmission lines, it is not possible to determine the significance of the electrical shock potential.

4.9.2.2 Requirement [10 CFR 51.53(c)(3)(ii)(H)]

If the applicant's transmission lines that were constructed for the specific purpose of connecting the plant to the transmission system do not meet the recommendations of the NESC for preventing electric shock from induced currents, an assessment of the impact of the proposed action on the potential shock hazard from the transmission lines must be provided.

4.9.2.3 Background [GEIS Section 4.9.1.1.5]

Design criteria for nuclear power plants that limit hazards from steady-state currents are based on the NESC, adherence to which requires that utility companies design transmission lines so that the short-circuit current to ground produced from the largest anticipated vehicle or object is limited to less than 5 mA. With respect to shock safety issues and license renewal, three points must be made. First, in the licensing process for the earlier licensed nuclear plants, the issue of electrical shock safety was not addressed. Second, some plants that received OLs with a stated transmission line voltage may have chosen to upgrade the line voltage for reasons of efficiency, possibly without reanalysis of induction effects. Third, since the initial NEPA review for those utilities that evaluated potential shock situations under the provision of the NESC, land use may have changed, resulting in the need for a reevaluation of this issue. The electrical shock issue, which is generic to all types of electrical generating stations, including nuclear plants, is of SMALL significance for transmission lines that are operated in adherence with the NESC. Without a review of the conformance of each nuclear plant's transmission lines, within this scope of review with NESC criteria, it is not possible to determine the significance of the electrical shock potential generically.

4.9.2.4 Analysis

As depicted in Figure 2.2-4, all in-scope transmission lines are located completely within an owner-controlled area as discussed in Section 3.1.2. Thus, no induced shock hazards would exist for the general public, due to restricted site access.

As discussed in Section 3.10, the FPL analysis to support the initial LR remains applicable. The 2000 analysis considered the lines from the plant's main transformers to the switchyard, as well as those from the switchyard to the Davis, Flagami, Florida City, Levee, and Doral substations. It took into account the FDOT limits on vehicle size and utilized a hypothetical 53-foot long by 13.5-foot high by 8.5-feet wide tractor-trailer. It determined the minimum vertical roadbed clearance is 38.1 feet when ambient temperatures are 120°F. (FPL 2000b, Section 4.13.2; NRC 2002a, Section 4.2.1)

The EPRI guidance methodology was utilized to perform the calculation of maximum short-circuit current. Worst-case parameters (voltage, current, conductor position) were input to the EZEMF computer program to determine the maximum electrical field strength 1 meter above the road. The position of the tractor-trailer was perpendicular to the phase conductors and the maximum short-circuit current was calculated assuming the maximum electric field value was applied to the entire length of the truck. The resulting value of this calculation was 2.00 kV/m. The resulting maximum steady-state short circuit current was 1.60 mA rms. The lines connecting the plant to the switchyard are in compliance with the NESC requirements. Similar calculations were conducted for the lines leaving the switchyard, and they too were determined to be below the allowable 5 mA rms. (FPL 2000b, Section 4.13.2)

The PTN in-scope transmission lines meet the NESC requirements based upon the above analysis, and the potential impacts from electric shock would be SMALL, pursuant to 10 CFR 51.53(c)(3)(ii)(H). Therefore, mitigation is not warranted.

4.10 Environmental Justice

The following sections address the environmental justice issues applicable to PTN, providing background on the issues and the analyses regarding the SLR period.

4.10.1 Minority and Low-Income Populations

4.10.1.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

Impacts to minority and low-income populations and subsistence consumption resulting from continued operations and refurbishment associated with license renewal will be addressed in plant-specific reviews. See NRC Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions (69 FR 52040; August 24, 2004).

4.10.1.2 Requirement [10 CFR 51.53(c)(3)(ii)(N)]

Applicants shall provide information on the general demographic composition of minority and low-income populations and communities (by race and ethnicity) residing in the immediate vicinity of the plant that could be affected by the renewal of the plant's OL, including any planned refurbishment activities, and ongoing and future plant operations.

4.10.1.3 Background [GEIS Section 4.10.1]

Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionately high environmental effects refer to impacts or risk of impact on the natural or physical environment in a minority or low-income community that are significant and appreciably exceed the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts. Minority and low-income populations are subsets of the general public residing around the site and all are exposed to the same risks and hazards generated from operating a nuclear power plant.

Continued reactor operations and other activities associated with license renewal could have an impact on air, land, water, and ecological resources in the region around each nuclear power plant site, which might create human health and environmental effects on the general population. Depending on the proximity of minority and low-income populations in relation to each nuclear plant, the environmental impacts of license renewal could have a disproportionate effect on these populations.

The location and significance of environmental impacts may affect population groups that are particularly sensitive because of their resource dependencies or practices (e.g., subsistence agriculture, hunting, or fishing) that reflect the traditional or cultural practices of minority and low-income populations. The analysis of special pathway receptors can be an important part of the identification of resource dependencies or practices. Special pathways take into account the levels of contaminants in native vegetation, crops, soils and sediments, surface water, fish, and game animals on or near the power plant sites in order to assess the risk of radiological exposure through subsistence consumption of fish, native vegetation, surface water, sediment, and local produce; the absorption of contaminants in sediments through the skin; and the inhalation of airborne particulates.

4.10.1.4 Analysis

4.10.1.4.1 Refurbishment Activities

As discussed in Section 2.3, no license renewal-related refurbishment activities have been identified. Therefore, there would be no license renewal-related refurbishment impacts to minority and low-income populations, and no further analysis is applicable.

4.10.1.4.2 Operational Activities

The consideration of environmental justice is required to assure that federal programs and activities will not have disproportionately high and adverse human health or environmental effects on minority populations and low-income populations. FPL's analyses of the Category 2 issues defined in 10 CFR 51.53(c)(3)(ii) determined that environmental impacts from the continued operation of PTN during the SLR period would either be SMALL or non-adverse. Therefore, high or adverse impacts to the general human population would not occur.

As described in Section 3.10.3, FPL maintains a REMP. In this program, FPL monitors important radiological pathways and considers potential radiation exposure to plant and animal life in the environment surrounding Turkey Point. Monitoring during the period 2011–2016 verified the dose commitment to members of the public resulting from operations at PTN were well within the ALARA criteria established by 10 CFR Part 50, Appendix I, and no adverse trends in the radiological environment were identified. Therefore, no environmental pathways have been adversely impacted and are not anticipated to be impacted during the PTN SLR term.

Section 3.11.2 identifies the locations of minority and low-income populations as defined by NRR Office Instruction LIC-203. Section 3.11.3 describes the search for subsistence populations near Turkey Point, of which none were found. The figures accompanying Section 3.11.2 show the locations of minority and low-income populations within a 50-mile radius of Turkey Point (see Figure 3.11-1 through Figure 3.11-20). None of those locations, when considered in the context of impact pathways described in Chapter 4, are expected to be disproportionately impacted.

Therefore, no disproportionately high and adverse impacts or effects on members of the public, including minority and low-income populations, are anticipated as a result of PTN SLR.

4.11 Waste Management

The following sections address the waste management issues applicable to PTN, providing background on the issues and the analyses regarding the SLR period.

4.11.1 Low-Level Waste Storage and Disposal

4.11.1.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL. The comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts to the environment would remain small during the license renewal term.

4.11.1.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.11.1.3 Background [GEIS Section 4.11.1.1]

The NRC believes that the comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts on the environment will remain SMALL during the term of a renewed license. The maximum additional onsite land that may be required for LLW storage during the term of a renewed license and associated impacts would be SMALL. Nonradiological impacts on air and water would be negligible. The radiological and nonradiological environmental impacts of long-term disposal of LLW from any individual plant at licensed sites are SMALL. In addition, the NRC concludes that there is reasonable assurance that sufficient LLW disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

4.11.1.4 Analysis

FPL would continue to manage and store LLW on site, as discussed in Section 2.2.6.3, in accordance with NRC regulations and dispose of LLW in NRC-licensed treatment and disposal facilities during the SLR period. As discussed above, there are comprehensive regulatory controls in place and FPL's compliance with these regulations and use of licensed treatment and disposal facilities would allow the impacts to remain SMALL during the SLR period. PTN's annual radiological environmental operating reports for years 2011–2016 indicated that doses to members of the public are well within ALARA criteria established by 10 CFR Part 50, Appendix I. Moreover, sampling by the DOH during those years also does not show adverse trends in levels of radiation and radioactive materials in publicly accessible areas. (PTN 2012b; PTN 2013b; PTN 2014c; PTN 2015b; PTN 2016b; PTN 2017b) No new and significant information has been identified for this issue; therefore, no further analysis is required. The issue was also considered in PTN's first license renewal's new and significant review, and no new and significant information was found at that time (FPL 2000b, Table 4.0-2).

4.11.2 Onsite Storage of Spent Nuclear Fuel

4.11.2.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

During the license renewal term, SMALL. The expected increase in the volume of spent nuclear fuel from an additional 20 years of operation can be safely accommodated onsite during the license renewal term with small environmental impacts through dry or pool storage at all plants.

For the period after the licensed life for reactor operations, the impacts of onsite storage of spent nuclear fuel during the continued storage period are discussed in NUREG-2157 and as stated in § 51.23(b), shall be deemed incorporated into this issue.

4.11.2.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.11.2.3 Background [GEIS Section 4.11.1.2 and NUREG-2157 ES.12 and Table ES-3]

As discussed in Section 3.11.1.2 (GEIS), spent nuclear fuel is currently stored at reactor sites either in spent fuel pools or in ISFSIs. The storage of spent fuel in spent fuel pools was considered for each plant in the safety and environmental reviews at the construction permit and OL stage. This onsite storage of spent fuel and HLW is expected to continue into the foreseeable future.

Interim storage needs vary among plants, with older units likely to lose pool storage capacity sooner than newer ones. Given the uncertainties regarding the final disposition of spent fuel and HLW, it is expected that expanded spent fuel storage capacity will be needed at all nuclear power plants.

NUREG-2157, *Generic EIS for Continued Storage of Spent Nuclear Fuel*, concluded on a generic basis for all nuclear power plants that spent fuel can be stored onsite for 60 years following the license term with small environmental effects.

4.11.2.4 Analysis

The additional 20 years of spent nuclear fuel generated during the SLR term would be stored in the spent fuel pools until adequately cooled and then transferred to dry storage in an ISFSI. The ISFSI is licensed under the general license provided to power reactor licensees under 10 CFR 72.210. The NRC-licensed design and operation of each of these storage options ensures that the increased volume in onsite storage can be safely accommodated with small environmental effects. No new and significant information has been identified for this issue; therefore, no further analysis is required. The issue was also considered in PTN's first license renewal's new and significant review, and no new and significant information was found at that time (FPL 2000b, Table 4.0-2).

4.11.3 Offsite Radiological Impacts of Spent Nuclear Fuel and High-Level Waste Disposal

4.11.3.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

For the HLW and spent-fuel disposal component of the fuel cycle, the EPA established a dose limit of 0.15 millisievert (mSv) (15 mrem) per year for the first 10,000 years and 1.0 mSv (100 mrem) per year between 10,000 years and 1 million years for offsite releases of radionuclides at the proposed repository at Yucca Mountain, Nevada.

NRC concluded that the impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent fuel and HLW disposal, this issue is considered Category 1.

4.11.3.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.11.3.3 Background [GEIS Section 4.11.1.3]

As a result of the *New York v. NRC* decision, and pending the issuance of a generic EIS and revised Waste Confidence Decision and Rule, the NRC has revised the Category 1 issue, "Offsite radiological impacts of spent nuclear fuel and high-level waste disposal." This issue pertained to the long-term disposal of spent nuclear fuel and HLW, including possible disposal in a deep geologic repository. Although the Waste Confidence Decision and Rule did not assess the impacts associated with disposal of spent nuclear fuel and HLW in a repository, it did reflect the Commission's confidence, at the time, in the technical feasibility of a repository and when that repository could have been expected to become available. Without the analysis in the Waste Confidence Decision, the NRC cannot assess how long the spent fuel will need to be stored onsite. Therefore, the NRC reclassifies this GEIS issue from a Category 1 issue with no assigned impact level to an uncategorized issue with an impact level of uncertain. Moreover, the ultimate disposal of spent nuclear fuel in a potential future geologic repository is a separate and independent licensing action that is outside the regulatory scope of license renewal.

4.11.3.4 Analysis

As indicated in GEIS Section 4.11.3.3, NRC's GEIS analysis of the issue was tied to rulemaking for the Waste Confidence Decision, which was pending in 2013 when Revision 1 of the license renewal GEIS was issued. As part of NRC's NEPA actions associated with the Waste Confidence

Decision, NRC reviewed the environmental impacts of away-from-reactor storage and the technical feasibility of disposal in a geologic repository in NUREG-2157, GEIS for Continued Storage of Spent Nuclear Fuel (NRC 2014a). In the final Continued Storage of Nuclear Spent Fuel rulemaking, the listing and classification of license renewal issues found in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 was revised to reclassify the impact determination for this issue as a Category 1 issue with no impact level assigned. This re-classification was upheld in May 2016 (81 FR 31532).

The NRC's August 2016 GEIS Supplement 57, prepared for LaSalle County Station, indicated that NRC is aware of no new and significant information on this issue (NRC 2016b, Section 4.13.1). Based on review of recent NRC documents and that PTN spent nuclear fuel will be disposed of offsite, FPL found no new and significant information, and further analysis is not required. Offsite radiological impacts of spent nuclear fuel and HLW disposal was also considered in PTN's first license renewal's new and significant review, and no new and significant information was found at that time (FPL 2000b, Table 4-2).

4.11.4 Mixed Waste Storage and Disposal

4.11.4.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL. The comprehensive regulatory controls and the facilities and procedures that are in place ensure proper handling and storage, as well as negligible doses and exposure to toxic materials for the public and the environment at all plants. License renewal would not increase the small, continuing risk to human health and the environment posed by mixed waste at all plants. The radiological and nonradiological environmental impacts of long-term disposal of mixed waste from any individual plant at licensed sites are small.

4.11.4.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.11.4.3 Background [GEIS Section 4.11.1.4]

Mixed waste is regulated both by the EPA or the authorized state agency under RCRA and by the NRC or the agreement state agency under the Atomic Energy Act (AEA; Public Law 83-703). The waste is either treated onsite or sent offsite for treatment followed by disposal at a permitted landfill. The comprehensive regulatory controls and the facilities and procedures that are in place at nuclear power plants ensure that the mixed waste is properly handled and stored and that doses to and exposure to toxic materials by the public and the environment are negligible at all plants. License renewal will not increase the small but continuing risk to human health and the environment posed by mixed waste at all plants. The radiological and nonradiological environmental impacts from the long-term disposal of mixed waste at any individual plant at licensed sites are considered SMALL for all sites.

4.11.4.4 Analysis

FPL previously established its radiological waste programs and controls as described in Section 2.2.6 in accordance with NRC regulations. FPL has established oversight and controls for handling and storage of hazardous and mixed waste that implements the regulatory requirements for management, storage, inspections, and shipping. Review of PTN's recent annual radiological environmental operating reports indicated that doses to members of the public are well within ALARA criteria established by 10 CFR Part 50, Appendix I. Moreover, sampling by the DOH during those years also does not show adverse trends in levels of radiation and radioactive materials in publically accessible areas. (PTN 2012b; PTN 2013b; PTN 2014c; PTN 2015b; PTN 2016b; PTN 2017b). PTN has not received any violations for hazardous waste management in the past 5 years based on a review of its compliance history (EPA 2017d).

FPL would continue to store and dispose of mixed waste in accordance with NRC, EPA, and state regulations and dispose of the wastes in appropriately permitted treatment and disposal facilities during the SLR period. As indicated in the GEIS (NRC 2013a), continuation of existing systems and procedures to ensure proper storage and disposal would allow the impacts to be of small magnitude. No new and significant information has been identified for this issue; therefore, no further analysis is required. This issue was evaluated as a Category I issue in PTN's first license renewal's new and significant review and found to be bound by the GEIS conclusion of a SMALL impact (FPL 2000b, Table 4.0-2).

4.11.5 Nonradioactive Waste Storage and Disposal

4.11.5.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL. No changes to systems that generate nonradioactive waste are anticipated during the license renewal term. Facilities and procedures are in place to ensure continued proper handling, storage, and disposal, as well as negligible exposure to toxic materials for the public and the environment at all plants.

4.11.5.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.11.5.3 Background [GEIS Section 4.11.1.5]

The management of hazardous wastes generated at all of these facilities, both onsite and offsite, is strictly regulated by the EPA or the responsible state agencies per the requirements of RCRA.

As does any industrial facility, nuclear power plants and the rest of the uranium fuel cycle facilities also generate nonradioactive nonhazardous waste. These wastes are managed by following good housekeeping practices and are generally disposed of in local landfills permitted under RCRA Subtitle D regulations.

In the 1996 GEIS, the impacts associated with managing nonradioactive wastes at uranium fuel cycle facilities, including nuclear power plants, were found to be SMALL. It was indicated that no changes to nonradioactive waste generation would be anticipated for license renewal, and that systems and procedures are in place to ensure continued proper handling and disposal of the wastes at all plants.

4.11.5.4 Analysis

Management of nonradioactive waste is discussed in Section 2.2.7. FPL has established oversight and controls for handling and storage of hazardous waste that implements the regulatory requirements for management, storage, inspections, and shipping. PTN has not received any violations for hazardous waste management in the past 5 years based on a review of its compliance history (EPA 2017d).

PTN's nonradiological, nonhazardous waste is disposed of by the Miami-Dade County Department of Solid Waste Management and is collected at the Turkey Point site by an approved solid waste collector (Section 2.2.7).

FPL would continue to store and dispose of hazardous and nonhazardous waste in accordance with EPA, state, and local regulations, and dispose of the wastes in appropriately permitted disposal facilities during the SLR period. As indicated in the GEIS (NRC 2013a), continuation of existing systems and procedures to ensure proper storage and disposal would allow the impacts to be of small magnitude. No new and significant information has been identified for this issue; therefore, no further analysis is required. This issue was evaluated as a Category I issue in PTN's first license renewal's new and significant review, and found to be bound by the GEIS conclusion of a SMALL impact (FPL 2000b, Table 4.0-2).

4.12 Cumulative Impacts

The following sections address the cumulative impacts applicable to PTN, providing background on the issues and the analyses regarding the SLR period.

Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

Cumulative impacts of continued operations and refurbishment associated with license renewal must be considered on a plant-specific basis. Impacts would depend on regional resource characteristics, the resource-specific impacts of license renewal, and the cumulative significance of other factors affecting the resource.

Requirement [10 CFR 51.53(c)(3)(ii)(O)]

Applicants shall provide information about other past, present, and reasonably foreseeable future actions occurring in the vicinity of the nuclear plant that may result in a cumulative effect.

Background [GEIS Section 4.13]

Actions to be considered in cumulative impact analyses include new and continuing activities, such as license renewal, that are conducted, regulated, or approved by a federal agency. The cumulative impacts analysis takes into account all actions, however minor, because impacts from individually minor actions may be significant when considered collectively over time. The goal of the analysis is to identify potentially significant impacts to improve decisions and move toward more sustainable development.

For some resource areas (e.g., water and aquatic resources), the contributions of ongoing actions within a region to cumulative impacts are regulated and monitored through a permitting process (e.g., NPDES) under state or federal authority. In these cases, it may be assumed that cumulative impacts are managed as long as these actions (facilities) are in compliance with their respective permits.

Analysis

The cumulative analysis involves determining if there is an overlapping of the anticipated impacts of the continued operation of PTN during the SLR period and past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such actions. Past and present actions include all actions up to and including the time of the SLRA. Future actions are those that are "reasonably foreseeable" (i.e., they are ongoing and will continue into the future), are funded for future implementation, are included in firm, near-term plans, or generally have a high probability of being implemented. The affected environment sections for each resource area presented in Chapter 3 generally accounts for past and present actions. Future actions would be those anticipated for the time from the SLRA submittal through the 20 years of the SLR period.

The direct and indirect impact analyses presented in Chapter 4 address the incremental impacts of SLR renewal. Those analyses are considered along with reasonably foreseeable future actions that have the potential to combine with the impacts of the proposed action to determine cumulative impacts. Next, the assessment determines if any combined impacts would be significant. Significant cumulative impacts could stem from an impact that may be small by itself but could result in a moderate and/or large impact when considered in combination with the impacts of other actions on the affected resource. If a resource is regionally declining or imperiled, even a small individual impact could be important if it contributes to or accelerates the overall resource decline.

Section 3.1.4 describes other (non-PTN) projects at and in the vicinity of Turkey Point. At the Turkey Point site, FPL operates Turkey Point Units 1 and 2 in synchronous condenser mode to provide voltage support for the transmission system, and Unit 5, a combined-cycle unit (employing four natural gas turbines and one heat-recovery steam-powered generator). No major changes to operations or plans for future expansion of these units are anticipated. Section 3.1.4 also introduces Units 6 and 7, for which FPL is seeking a license from NRC. FPL has not made a decision to construct the units; however, for the purpose of assessing cumulative impacts to support the SLRA, the construction and operation of Units 6 and 7 is considered. There are no Turkey Point site projects anticipated, planned, or projected (other than construction and operation of Turkey Point 6 and 7 and continued operation of PTN and the continued operation of Units 1 and 2 in synchronous condenser mode and continued operation of Unit 5) during the SLR period. Another ongoing project locally and throughout the region is the CERP. These onsite projects and the CERP could result in cumulative impacts.

The overlap of construction of the units with the SLR period is not a matter of certainty. The earliest practical dates for bringing Turkey Point Units 6 and 7 in service are mid-2027 (Unit 6) and mid-2028 (Unit 7) (FPL 2017a). These earliest in-service dates for the units would mean that there would not be an overlap; however, it is reasonable to conservatively assume a site preparation and construction schedule for Units 6 and 7 that is delayed into the SLR period of PTN. Therefore, here and where appropriate, the impacts of construction as well as the impacts of operation of the proposed units is considered in the cumulative impacts analysis.

The NRC recently conducted a cumulative impacts assessment of the construction and operation of the proposed Turkey Point Units 6 and 7 in the EIS prepared for the COL for these proposed units (NRC 2016a). This cumulative impacts assessment considered the operation of PTN with the many past, present, and future projects in the area. The NRC developed a comprehensive list of projects and activities within a 50-mile radius and reviewed the potential for urban development as governed by state and local land use plans. This recent cumulative assessment is applicable to a cumulative impacts assessment for this SLRA for PTN and is the primary resource for this cumulative assessment.

The following sections address the potential for cumulative impacts by resource area.

4.12.1 Land Use and Visual Resources

PTN SLR is not anticipated to require land use changes, but would be a continuation of previously established land use for power generation. As described in Section 3.2.2, the areas surrounding Turkey Point are primarily water (i.e., Biscayne Bay) and wetlands. The large developed areas within a 6-mile vicinity are Homestead ARB and Homestead (Figure 3.2-2). The Adopted 2020–2030 Land Use Plan for Miami-Dade County, Florida (MDC 2016b) shows the lands surrounding Turkey Point as land designated as environmentally protected. The Miami-Dade County 2015−2025 Comprehensive Development Plan designated the unincorporated land in the immediate vicinity of the Turkey Point site as protected land, open land, parkland, or agricultural land (NRC 2016a, Section 7.1). Both the previous plan and the current plan indicate that land use in the vicinity of the Turkey Point site would not be expected to change.

The Units 6 and 7 EIS cumulative land use impacts analysis considered a 10-mile radius beyond the site proposed for the units, which is just south of the PTN location, as the geographic area of interest (NRC 2016a, Section 7.1). Projects considered in the cumulative impacts analysis included many ongoing projects including those on site and the conservation and remediation projects for the environmentally protected land surrounding Turkey Point (NRC 2016a, Table 7-1). In addition, the EIS considered freshening activities for improving water quality in the Turkey Point cooling canals and remediation of the hypersaline plume. The cumulative impact on land use would be MODERATE, with the incremental contribution of construction and operation of Units 6 and 7 being a significant contributor (EIS concluded that the construction and operation of Units 6 and 7 would be MODERATE).

Given that the proposed continued operation of PTN is not anticipated to require land use changes, the contribution of continued operation of PTN would be a small contributor to the overall moderate cumulative impact to land use.

The continued use of existing structures associated with PTN would not alter their visual impact. As discussed in Section 3.2.3, the containment structures are screened by vegetation on the landward side and clearly visible from Biscayne Bay. Proposed Units 6 and 7 would add to this viewscape, but because Units 6 and 7 would be built adjacent to existing units and from materials that are architecturally similar, the contrast with the existing landscape would be reduced; thus, the NRC concluded that the visual impact of Units 6 and 7 would be SMALL. Furthermore, the existing units lighting is visible at night from various locations landward and the addition of operational lighting at the proposed units was deemed to be minor.

The NRC also determined the visual impacts from construction of the units would also be SMALL (NRC 2016a, Sections 4.4.1.6, 4.12, 5.4.1.6, and 5.4.1.7). As mentioned above, the surrounding land is designated as environmentally protected and is thus not anticipated to undergo development. Therefore, the cumulative visual impacts would be those of the existing and proposed units. With the NRC previously determining the new units would have a SMALL visual impact, the combination of the existing units and the proposed units would have a cumulative small visual impacts.

4.12.2 Air Quality and Noise

4.12.2.1 Air Quality

As discussed in Section 3.3.3, Miami-Dade County where Turkey Point is located is in attainment of the NAAQSs. PTN air pollutant emissions are minor air emission sources and their minimal emissions stem from intermittent use and testing of EDGs and diesel pumps. The non-nuclear operations of PTN are permitted by a Title V air emissions permit (Permit No. 0250003-021-AV) (FDEP 2014a). The PTN air permit contains conditions established by the FDEP to protect

Florida's ambient air quality standards and ensure impacts are maintained at acceptable levels. As discussed in Section 2.3, no refurbishment or future upgrades or replacement activities have been identified; therefore, no increase or decrease of air emissions is expected over the SLR period. Section 4.2.1.4 concluded that the impact to air quality from the continued operation of PTN during the SLR term is anticipated to be small as generically determined by the NRC for all nuclear power plants.

The Units 6 and 7 EIS conducted an air quality cumulative impact analysis inclusive of the existing Turkey Point Units 1-5 (with Units 1 and 2 operating in synchronous condenser mode) and other past, present, and future projects (including other existing fossil fuel-fired power plants, planned and existing MSW incinerators, and power generation projects) (NRC 2016a, Table 7-1 and Section 7.6.1). The geographic area of interest was established as Miami-Dade County, and the county was in attainment for the NAAQSs at that time, as is the current condition. The NRC analysis concluded that cumulative air quality impacts due to criteria pollutants would SMALL to MODERATE. The NRC noted the following contributors to this conclusion to be the potential for growth and the contribution of criteria pollutant emissions from the three landfill gas power-generation projects.

Given the SLR for PTN does not include an increase in air emissions and the recent NRC cumulative analysis concluded SMALL to MODERATE impacts, the cumulative air quality impacts are anticipated to be small to moderate with the continued operation of PTN being only a minor contributor to the cumulative impact. In contrast, as presented in Section 7.2, replacement of PTN with a natural gas plant would be an addition of a major air emission source, resulting in a greater incremental contribution to air pollution.

4.12.2.2 Climate Change

The annual GHG emissions for the period 2012–2016 from PTN are presented in Table 3.3-10. The NRC estimated GHG emissions for the lifetime of a 1,000-MWe reactor at 10,500,000 MT carbon dioxide equivalent (CO_2e). This is equal to approximately 37.5 g CO_2e per kilowatt hour (CO_2e/kWh). (NRC 2013d) The contributions of PTN, which are less than 1,000 MWe each, for the 20 years of operation during the SLR term would be less than the estimate the NRC prepared for the 1,000-MWe reactor.

It is difficult to evaluate cumulative impacts of GHG emissions on a local level; the NRC evaluated GHG cumulative impacts on a global level in its guidance. GHG cumulative impacts on a global level indicate that national and worldwide cumulative impacts of GHG emissions are MODERATE, with or without the GHG estimated for the lifetime of a 1000-MWe reactor. (NRC 2013e)

NRC's EIS for proposed Units 6 and 7 also discussed cumulative impacts of GHG emissions on a global scale as well as on a national scale, concluding that the cumulative impact would be MODERATE based on EPA and U.S. Global Change Research Program reports. The EIS further concluded that the cumulative impacts would be MODERATE, whether or not the proposed units were constructed and operated. (NRC 2016a) The GHG contribution of PTN during the SLR period would be minor and would be less than the contribution from the construction of the proposed Units 6 and 7, which would require mobilization of hundreds of construction workers daily, and transport and manufacturing of building materials and components. Therefore, while the cumulative impact would be moderate, the contribution of continued operation of PTN would be negligible. Moreover, continued operation of PTN avoids millions of tons of carbon dioxide (CO_2) from alternative fossil-fuel generation, positively impacting the climate change factor of CO_2 concentrations.

4.12.2.3 Noise

PTN operations have a small impact on the noise environment as described in Section 4.3.4. As mentioned above, the surrounding land is designated as environmentally protected and is not anticipated to undergo development. Therefore, the cumulative noise impacts would be those of the existing and proposed units. The NRC determined the noise impacts from construction and operation of the proposed Units 6 and 7 would also be SMALL. Peak noise from construction of the proposed Units 6 and 7 was estimated to be below 65 dBA at the nearest residence, a level considered to be a small significance. (NRC 2016a, Sections 4.4.1.1, 4.12, and 5.4.1.1) With the NRC previously determining that even the peak construction noise of the proposed units would have a SMALL noise impact, the combination of the existing units, including continued operation of PTN, and the proposed units would have a cumulative small noise impact.

4.12.3 Geology and Soils

Impacts to geology and soils could result from ground-disturbing activities and stormwater runoff. Routine infrastructure, renovation, and maintenance projects would be expected during continued operation. Stormwater is routed to the cooling canals. As discussed in Section 3.5.3.2, stabilization measures are in place to prevent erosion and sedimentation impacts to the site and vicinity. Section 4.4.4 concluded that PTN's impact on geology and soils would be small. No new development attributable to PTN during the SLR period is anticipated, and any new development would be subject to state and local stormwater management requirements.

Stormwater runoff from the construction and operations period of the proposed Units 6 and 7 would be routed to the cooling canals and stormwater management basins before release to the surrounding wetland area. No direct stormwater discharges would be made to Biscayne Bay. SFWMD reviewed stormwater management and surmised that stormwater mitigation could be achieved through the planned BMPs, and impacts to offsite water resources would be minimal. (NRC 2016a, Sections 4.2.1.1 and 5.2.1.6)

As mentioned in Section 4.12.1, the land surrounding Turkey Point is designated as environmentally protected, indicating that little to no construction activities would be taking place adjacent to the Turkey Point boundary. Given ground disturbances at the PTN site and that the surrounding area would be subject to stormwater permitting and applicable BMPs, the cumulative impact to geology and soils would be small.

4.12.4 Water Resources

4.12.4.1 Surface Water

Surface water resource impacts would stem from alterations in hydrology, withdrawals, discharges, and stormwater. PTN does not withdraw water from surface water resources and the units' discharges, including stormwater, are to the closed-cycle cooling canals. There are no construction or refurbishment plans related to the proposed action, thus no alterations in hydrology are anticipated. The cooling canals, the groundwater wells associated with the cooling canals, and the cooling canals' interface with groundwater are discussed in Section 3.6. The compliance history associated with the cooling canals freshening and hypersaline recovery is presented in Section 3.6.1.4.5. The cooling canals' effect on surface water through the groundwater interface was studied in sampling events in 2010–2017. The results indicated that the groundwater pathway is having no discernable influence on Biscayne Bay (EEI 2017).

NRC's Units 6 and 7 EIS analyzed cumulative impacts to surface water quality in surface waters adjacent to the Turkey Point site. The EIS considered the contributing projects to be those of Turkey Point existing and proposed units, and historical point and non-point-source discharges have affected the water quality of streams and rivers near Turkey Point. The EIS considered that some water bodies near Turkey Point are listed as impaired (CWA 303[d]) and designation of the waters of Biscayne National Park as an Outstanding Florida Water. The EIS analysis determined that cumulative impacts would be MODERATE, with the proposed Units 6 and 7 contribution being of small significance. (NRC 2016a) Given that PTN do not discharge to surface waters and have stormwater controls in place, they likewise would have a contribution of small significance within the MODERATE cumulative impact.

4.12.4.2 Groundwater

PTN operations include groundwater withdrawals for process water and freshening of the cooling canals, recovery of hypersaline groundwater, underground injection of wastewater and, as discussed above, migration of water in the cooling canals of the IWW facility into groundwater. In addition, FPL has groundwater withdrawal wells located at Turkey Point (PW-1, PW-3, and PW-4) for process water for other operating units. All of these wells are discussed in Section 3.6.3.2. Section 4.5.3.4 discusses the impacts of groundwater withdrawals and concluded that the withdrawals are within permitted quantities.

The EIS prepared by NRC for Turkey Point Units 6 and 7 analyzed cumulative impacts to groundwater considering the groundwater withdrawals and injections of PTN and the other Turkey Point facilities and those from other projects and activities in the surrounding area (e.g., impacts of enhanced recharge to the Biscayne Aquifer from activities related to CERP and offsite wastewater-injection operations). The NRC determined the cumulative impacts to be SMALL given the hydrologic characteristics of the affected aquifers, fate and transport processes, and the monitoring and management programs required by the State. (NRC 2016a)

As indicated in Section 4.12 of NRC Regulatory Guide 4.2, Revision 1 (NRC 2013b), it may be assumed that cumulative impacts are managed as long as facility operations are in compliance with their respective permits. Given that FPL continues to comply with its permits for groundwater withdrawals and injection, the FDEP CO for freshening of the cooling canals, and the CA with Miami-Dade County for remediation of the hypersaline plume, cumulative impacts would be managed, and continued operation of PTN during the SLR period would be small.

4.12.4.3 Climate Change

Aside from GHG levels discussed in Section 4.12.2.2, other climate change indicators are trends in increasing air temperature, precipitation, and water temperature. The reliance of PTN on closed-cycle cooling using the cooling canals limits the opportunities for operation of the units to contribute to these factors due to the reuse of water and no discharge. Extensive studies were conducted by FPL to determine the effects, if any, of the CCS on surface water via the groundwater pathway. The results indicated that the groundwater pathway is having no discernable influence on Biscayne Bay. The results indicate that water temperature in Biscayne Bay is influenced by seasonal and meteorological conditions. The increase in cooling canals water temperatures during the post-uprate period do not correspond with commensurately higher air temperatures. As for precipitation, the results from 2010 through 2017 showed differences in rainfall between stations, as may be expected over the large area of sampling. However, there was no increasing trend in rainfall for the stations or relative trends among the stations (EEI 2017, Sections 2.2.2, 2.4.2, and 5.1).

So, while national and global trends may show warming trends, the available data indicate that the no-discharge, closed-loop cooling used by PTN would also be a small contributor to local and regional warming trends. Moreover, continued operation of PTN avoids millions of tons of CO_2 from alternative fossil-fuel generation, positively impacting the climate change factor of CO_2 concentrations.

4.12.5 Ecological Resources

4.12.5.1 Terrestrial

The affected environment for terrestrial ecological communities is described in Section 3.7 and represents the cumulative impact of past and present activities on site and in the surrounding area of environmental protected lands.

As discussed above, FPL conducted pre-and post-uprate studies during the period 2010–2017 to determine the influence of the cooling canals on the surrounding areas through migration of groundwater. The results indicate that the cooling canals do not have any ecological impact on the surrounding areas (PTN 2017, Executive Summary).

The cooling canals are the home to the threatened American crocodile. As discussed in Section 4.6.6.4, the cooling canals provide habitat for the species, and FPL has a management plan in place to support the population and minimize adverse impacts. Section 4.6.6.4 concludes that the continued operation of the site would have no adverse effects on any federally or state-listed species.

As discussed in Sections 3.7.8.1 and 4.6.6.4, habitat for federally and state-listed terrestrial species other than the American crocodile does occur on or immediately adjacent to the Turkey Point site. However, adherence to regulatory and permit requirements to avoid take of protected species and FPL administrative controls, such as those regarding response to avian collisions with transmission lines, will minimize or avoid impact to these species. FPL is not aware of any adverse impacts regarding threatened, endangered, and protected species attributable to the site. Maintenance activities necessary to support SLR likely would be limited to previously disturbed areas on site. Lands adjacent to the Turkey Point site are designated as environmentally protected and, therefore, development is not expected. Therefore, cumulative impacts on protected species would be small.

In its EIS for proposed Units 6 and 7, the NRC concluded that the overall cumulative impacts on terrestrial resources within a 50-mile radius from past, present, and reasonably foreseeable future actions would be MODERATE to LARGE, with particular consideration of the impacts of Units 6 and 7, habitat loss and degradation from past, ongoing, and anticipated regional land development; the sensitivity of terrestrial habitats in the region to hydrological changes; the number and distribution of federally and state-listed species present in the region; and the presence of two national parks and numerous other conservation lands in the area. The contribution of construction and operation of Units 6 and 7 were assessed by the NRC as a MODERATE contributor to this overall impact significance. (NRC 2016a, Section 7.3.1)

The USFWS biological opinion for federally listed species with regard to the construction and operation of the proposed Turkey Point Units 6 and 7 project concluded that the project as proposed is not likely to jeopardize the continued existence of the crocodile, indigo snake, snail kite, panther, red knot, or wood stork, and it will not adversely modify the critical habitat of the crocodile. The USFWS also concluded that the project was not likely to adversely affect the Florida bonneted bat, Bartram's scrub-hairstreak butterfly, Florida leafwing butterfly, Miami tiger beetle, and Schaus swallowtail butterfly, Beach jacquernontia, Carter's small-flowered flax, crenulate lead-plant, deltoid spurge, Florida brickell-bush, Garber's spurge, Small's milkpea tiny polygala, piping plover, and the West Indian manatee. (USFWS 2017e)

Given that continued operation of PTN does not include the construction of new facilities and that ongoing remediation activities associated with the cooling canals would be conducted in compliance with state and local requirements and monitoring would be conducted to ensure its effectiveness, the contribution to the overall cumulative impacts to terrestrial habitats including wetlands and terrestrial species communities would be small.

4.12.5.2 Aquatic

The aquatic ecological communities could be impacted through discharges to the surface waters and wetlands. PTN's cooling canals are closed loop and do not discharge to surface waters; however, the cooling canals are unlined so they have an interface with underlying groundwater. Stormwater is also routed to the cooling canals. As discussed above, pre- and post-uprate studies and continued monitoring were undertaken to determine any influence on the surrounding surface and groundwater due to seepage from the unlined cooling canals. The studies' data support the conclusion that the cooling canals do not have any ecological impact on the surrounding areas, and there is no evidence of cooling canal water in the surrounding marsh and mangroves areas from a groundwater pathway (EEI 2017, Executive Summary).

NRC's Units 6 and 7 EIS also conducted a cumulative impact assessment for impacts on aquatic ecological communities using a geographic area of interest of all the aquatic resources in southeastern Florida. The NRC determined the cumulative impact to be MODERATE, primarily based on past activities that altered the hydrology of the region. Other activities noted by the NRC were success or failure of existing and pending restoration CERP activities, continued urbanization in southern Florida, and the magnitude of hydrological alterations as a result of climate change. NRC's assessment determined that the proposed and existing Turkey Point units' contribution would be SMALL to the cumulative impacts. The NRC further indicated that their previous assessments of PTN operations indicated that their impact on aquatic communities were limited to those in the cooling canals. (NRC 2016a, Section 7.3.2)

Given that FPL will continue to manage the cooling canals in compliance with its IWW permit, continue to comply with the AO regarding improving water quality in the canals, and continue to implement its American crocodile management plan, the continued contribution of PTN to cumulative impacts during the SLR period would be small.

4.12.5.3 Climate Change

Terrestrial and aquatic species could be vulnerable to the air and water temperature warming trends and rising sea levels. As discussed in Sections 4.12.2.2 and 4.12.4.3, the cumulative impact of climate change on a national level was assessed previously to be MODERATE. Given PTN's no-discharge cooling system and data indicating that cooling water discharges are not indicated in local air, water temperature, and precipitation trends, the continued operation of the PTN would be a small contributor to climate change effects that impact vulnerable species.

4.12.6 Historic and Cultural Resources

As discussed in Sections 3.8.5 and 4.7.4.2, there have been seven previous cultural resource investigations conducted on the Turkey Point site. There are no recorded cultural resources on the Turkey Point site and there are no NRHP-listed resources within a 6-mile radius of Turkey Point. As discussed in Section 3.8.6, FPL has administrative controls in place for management of cultural resources ahead of any future ground-disturbing activities at the plant. These consist of the 2016 conditions of certification (FDEP 2016a) and the Environmental Control Program for PTN. Section 4.7.4.2 concluded that no adverse effects are anticipated during the PTN SLR term.

NRC's Units 6 and 7 EIS cumulative land use impacts analysis considered the direct and indirect APE determined for the construction and operation of proposed Units 6 and 7 as the geographic area of interest. The direct-effects APE is the area that may be physically affected by land-disturbing activities, and the indirect-effects APE is the area that may be visually and/or auditory affected. The Units 6 and 7 project includes construction of the units' onsite and offsite facilities, including transmission corridors. The indirect-effects APE applicable to the onsite portions is determined by the maximum distance from which the tallest structures associated with proposed Units 6 and 7 can be seen from offsite locations. In the case of the Turkey Point site, the indirect-effects APE was determined to be 0.5 miles from the facility. The NRC's cumulative impact assessment, which included consideration of the transmission corridor, was MODERATE; however, the NRC stated that incremental impacts associated with the onsite NRC-authorized activities for Units 6 and 7 would not significantly contribute to the cumulative impact, because no significant historic or cultural resources would be affected by these activities in the geographic area of interest. (NRC 2016a, Sections 2.7 and 7.5)

NRC's Units 6 and 7 EIS assessment and the Section 4.7.4.2 assessment indicates that there would not be an overlap of impacts resulting in cumulative impacts; therefore, cumulative impacts to cultural resources from this SLR are not anticipated.

4.12.7 Socioeconomics

The SLR does not include additional workers (Section 4.8.1.4) so the small adverse impacts that are the result of workers' impact on community services, education, and infrastructure, including transportation, would continue. As discussed in Section 4.5.1.4, the demand for municipal water for plant use is being reduced and this reduced usage would be applicable to the SLR term. Tax payments from the operating plant (Section 4.8.2.4) are anticipated to continue without significant change through the SLR period and the economic contributions of the plant's workers, thus the beneficial socioeconomic impacts would also continue. FPL also does not have currently have plans to expand or contract operations at the other existing units during the SLR period, so their contributions to the taxable value of Turkey Point is anticipated to continue. However, operational Units 6 and 7 would impact the Turkey Point site's taxable value. In addition, construction of the proposed units would impact socioeconomics through increased employment directly and indirectly by adding to the local economy and placing greater demand on community services and infrastructure.

NRC's Units 6 and 7 EIS considered the cumulative impacts of the proposed units, existing units, and other past, present, and future projects using Miami-Dade County as the geographic area of interest. The EIS determined the adverse cumulative impact to be SMALL with the exception of traffic in the vicinity of the proposed units, which would be MODERATE with the proposed units being the principal contributor to the traffic impact. (NRC 2016a)

Given that continued operation of PTN would allow employment levels and tax payments to be consistent with current levels, the cumulative impacts determined in the Units 6 and 7 EIS, considering construction and operation, remain applicable; therefore, cumulative socioeconomic impacts would be small with the exception of moderate traffic impacts in the vicinity of Turkey Point resulting from the addition of the proposed Units 6 and 7.

4.12.8 Human Health

Operating PTN for an additional 20-year period is not expected to cause an increase in annual radioactive effluent releases. The NRC concluded that the cumulative radiological impacts of operating the existing and proposed Turkey Point units and the influence of other manmade sources of radiation nearby would be SMALL (NRC 2016a, Section 7.8). The cumulative impact of the units and the proposed units along with any existing or proposed medical, industrial, and research facilities using radioactive materials in the region during the SLR period would be small, because all routine releases by the facilities and occupational exposure to their employees would be subject to federal and state regulations designed to ensure radioactive emissions and occupational exposure do not significantly impact human health.

4.12.9 Waste Management

As discussed in Section 4.11.1.4, the comprehensive regulatory controls in place for management of radiological waste, FPL's compliance with these regulations, and use of only licensed treatment and disposal facilities would allow the impacts to remain SMALL during the SLR term. There are no other operating nuclear power plants, fuel-cycle facilities, or radiological waste treatment and disposal facilities within a 50-mile radius of PTN. There are industrial, medical, and research facilities in the region that use radioactive materials.

NRC's Units 6 and 7 EIS analyzed the cumulative impacts of managing radioactive waste within a 50-mile radius of PTN and determined the cumulative impact to be SMALL (NRC 2016a, Section 7.8)

FPL would continue its programs of radioactive waste management and comply with waste management guidelines and discharge limits. Given that NRC, EPA, and state authorities would likely continue ensuring licensed facilities are available for waste treatment and disposal, and FPL's ongoing waste management practices, the cumulative impact of radioactive waste management would be small.

Section 4.11.5.4 concluded that continued operation of PTN would have a small impact on nonradioactive waste management facilities given FPL's program for waste management and the availability of treatment and disposal facilities. NRC's Units 6 and 7 EIS analyzed cumulative impacts of nonradioactive waste from the past, present, and future projects in the geographic area of interest of Miami-Dade County. The EIS concluded that cumulative impacts from nonradioactive waste management would be SMALL. (NRC 2016a, Section 7.9) FPL would continue its programs of waste management and comply with permits and waste management regulations. Given that facilities within Miami-Dade County are also required to comply with appropriate EPA and state requirements for the management of hazardous and nonhazardous waste, that state and local authorities would continue ensuring permitted facilities are available for waste treatment and disposal, and FPL's ongoing waste management practices, the cumulative impact of nonradioactive waste management would be small.

4.13 Impacts Common to all Alternatives: Uranium Fuel Cycle

The following sections address the fuel cycle issues applicable to PTN, providing background on the issues and the analyses regarding the SLR period.

4.13.1 Offsite Radiological Impacts—Individual Impacts from other than the Disposal of Spent Fuel and High-Level Waste

4.13.1.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL. The impacts to the public from radiological exposures have been considered by the Commission in Table S-3 of this part. Based on information in the GEIS, impacts to individuals from radioactive gaseous and liquid releases, including radon-222 and technetium-99, would remain at or below the NRC's regulatory limits.

4.13.1.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.13.1.3 Background [GEIS Section 4.12.1.1]

The primary indicators of impact are the concentrations of radionuclides in the effluents from the fuel cycle facilities and the radiological doses received by a maximum exposed individual (MEI) on the site boundary or at some location away from the site boundary. The basis for establishing the significance of individual effects is the comparison of the releases in the effluents and the MEI doses with the permissible levels in applicable regulations. The analyses performed by the NRC in the preparation of Table S-3 and found in the 1996 GEIS indicate that as long as the facilities operate under a valid license issued by either the NRC or an agreement state, the individual effects will meet the applicable regulations. On the basis of these considerations, the NRC has concluded that the impacts on individuals from radioactive gaseous and liquid releases during the license renewal term would remain at or below the NRC's regulatory limits. Accordingly, the NRC concludes that offsite radiological impacts of the uranium fuel cycle (individual effects from sources other than the disposal of spent fuel and HLW) are SMALL.

4.13.1.4 Analysis

This issue concerns the direct individual impacts from facilities involved in supplying nuclear fuel to nuclear power plants. The issue was considered in FPL's new and significant review and no new and significant information was identified as it relates to offsite radiological impacts—individual impacts from other than the disposal of spent fuel and HLW; therefore, no further analysis is required. The issue was also considered in PTN's first license renewal's new and significant review, and no new and significant information was found at that time (FPL 2000b, Table 4.0-2).

4.13.2 Offsite Radiological Impacts—Collective Impacts from other than the Disposal of Spent Fuel and High-Level Waste

4.13.2.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

There are no regulatory limits applicable to collective doses to the general public from fuel-cycle facilities. The practice of estimating health effects on the basis of collective doses may not be meaningful. All fuel-cycle facilities are designed and operated to meet the applicable regulatory limits and standards. The Commission concludes that the collective impacts are acceptable.

The Commission concludes that the impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the collective impacts of the uranium fuel cycle, this issue is considered Category 1.

4.13.2.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.13.2.3 Background [GEIS Section 4.12.1.1]

There are no regulatory limits applicable to collective doses to the general public from fuel cycle facilities. All regulatory limits are based on individual doses. All fuel cycle facilities are designed and operated to meet the applicable regulatory limits.

As discussed in the 1996 GEIS, despite the lack of definitive data, some judgment as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgment in every case. The Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the collective effects of the fuel cycle, this issue was considered Category 1.

4.13.2.4 Analysis

This issue concerns the direct collective impacts from facilities involved in supplying nuclear fuel to nuclear power plants. The issue was considered in FPL's new and significant review and no new and significant information was identified as it relates to offsite radiological impacts—collective impacts from other than the disposal of spent fuel and HLW; therefore, no further analysis is required. The issue was also considered in PTN's first license renewal's new and significant review, and no new and significant information was found at that time (FPL 2000b, Table 4.0-2).

4.13.3 Nonradiological Impacts of the Uranium Fuel Cycle

4.13.3.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL. The nonradiological impacts of the uranium fuel cycle resulting from the renewal of an OL for any plant would be small.

4.13.3.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.13.3.3 Background [GEIS Section 4.12.1.1]

Data on the nonradiological impacts of the fuel cycle are provided in Table S-3. These data cover land use, water use, fossil fuel use, and chemical effluents. The significance of the environmental impacts associated with these data was evaluated in the 1996 GEIS on the basis of several relative comparisons. It was noted that the impacts associated with uses of all of the above resources would be SMALL. Any impacts associated with nonradiological liquid releases from the fuel cycle facilities would also be SMALL. As a result, the aggregate nonradiological impact of the uranium fuel cycle resulting from the renewal of an OL for a plant would be SMALL, and it was considered a Category 1 issue in the 1996 GEIS.

4.13.3.4 Analysis

This issue concerns the direct nonradiological impacts from facilities involved in supplying nuclear fuel to nuclear power plants. The issue was considered in FPL's new and significant review, and no new and significant information was identified as it relates to nonradiological impacts of the uranium fuel cycle; therefore, no further analysis is required. The issue was also considered in PTN's first license renewal's new and significant review, and no new and significant information was found at that time (FPL 2000b, Table 4.0-2).

4.13.4 Transportation

4.13.4.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL. The impacts of transporting materials to and from uranium-fuel-cycle facilities on workers, the public, and the environment are expected to be small.

4.13.4.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.13.4.3 Background [GEIS Section 4.12.1.1]

The impacts associated with transporting fresh fuel to one 1,000 MWe model light-water reactor and with transporting spent fuel and radioactive waste (LLW and mixed waste) from that light water reactor are provided in Table S-4 in 10 CFR 51.52. Similar to Table S-3, and as indicated in 10 CFR 51.52, every ER prepared for the construction permit stage of a commercial nuclear power plant must contain a statement concerning the transport of fuel and radioactive waste to and from the reactor. A similar statement is also required in LRAs. Table S-4 forms the basis of such a statement.

In 1999, the NRC issued an addendum to the 1996 GEIS in which the agency evaluated the applicability of Table S-4 to future license renewal proceedings, given that the spent fuel is likely to be shipped to a single repository (as opposed to several destinations, as originally assumed in the preparation of Table S-4) and given that shipments of spent fuel are likely to involve more highly enriched fresh fuel (more than 4 percent as assumed in Table S-4) and higher-burnup spent fuel (higher than 33,000 MWd/MTU as assumed in Table S-4). In the addendum, the NRC evaluated the impacts of transporting the spent fuel from reactor sites to the candidate repository at Yucca Mountain and the impacts of shipping more highly enriched fresh fuel and higher-burnup spent fuel. On the basis of the evaluations, the NRC concluded that the values given in Table S-4 would still be bounding, as long as the (1) enrichment of the fresh fuel was 5 percent or less, (2) burnup of the spent fuel was 62,000 MWd/MTU or less, and (3) higher-burnup spent fuel (higher than 33,000 MWd/MTU) was cooled for at least 5 years before being shipped offsite.

4.13.4.4 Analysis

The NRC did not revisit the radiological impact analysis of transporting spent nuclear fuel to away from reactor storage locations in the 2014 GEIS for Continued Storage of Spent Nuclear Fuel and again stated that the radiological impact analysis can be found in Table S-4 (NRC 2014a).

As stated above, the NRC considered the impacts of this issue to be SMALL provided three conditions were met. As discussed in Section 2.2.1, the fuel used at PTN is enriched to a maximum of 5.0 percent, and the equilibrium core maximum fuel discharge burnup rate is approximately 62,000 MWd/MTU. Furthermore, as discussed in Section 2.2.6.5, spent fuel is stored on site in each of the units' spent fuel pools prior to transfer to onsite dry storage. The environmental assessment for the EPU determined that spent fuel management was bounded by the impacts analyzed in Table S-4 (NRC 2012b). The issue was considered in FPL's new and significant review, and no new and significant information was identified as it relates to nonradiological impacts of the uranium fuel cycle; therefore, no further analysis is required. The issue was also considered in PTN's first license renewal's new and significant review, and no new and significant information was found at that time (FPL 2000b, Table 4.0-2).

4.14 Termination of Nuclear Power Plant Operations and Decommissioning

The following sections address the issue of license termination and decommissioning, providing background on the issue and an analysis of the issue as it applies to the SLR period.

4.14.1 Findings from 10 CFR Part 51, Subpart A, Appendix B, Table B-1

SMALL. License renewal is expected to have a negligible effect on the impacts of terminating operations and decommissioning on all resources.

4.14.2 Requirement [10 CFR 51.53(c)(3)(iv)]

The ER must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

4.14.3 Background [GEIS Sections 4.12.2 and 4.12.2.1]

The NRC evaluated the impacts of decommissioning nuclear plants in NUREG-0586, the *Generic Environmental Impact Statement for Decommissioning Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors* (NRC 2002b).

This section describes and discusses the environmental consequences of terminating nuclear power plant operations and decommissioning, but the only impacts attributable to the proposed action (license renewal) are the effects of an additional 20 years of operations on the impacts of decommissioning. The majority of the impacts associated with plant operations would cease with reactor shutdown; however, some impacts would remain unchanged, while others would continue at reduced or altered levels. Some new impacts might also result directly from terminating nuclear power plant operations.

Terminating nuclear power plant operations would result in the cessation of actions necessary to maintain the reactor, as well as a significant reduction in the workforce. NRC presumes that terminating nuclear power plant operations would not immediately lead to the dismantlement of the reactor or other infrastructure, much of which would still be in use to support other units on site that continued to operate. Even for sites with just one unit, some facilities would remain in operation to ensure that the site was maintained in safe shutdown condition.

4.14.4 Analysis

Only the incremental increase in the impacts of termination of plant operations and decommissioning attributable to continued operation during the SLR term is within the scope of this issue. The additional operating years would generate additional spent nuclear fuel to be managed during the decommissioning period, as well as potentially greater volumes of radioactive waste or radioactive materials. The proposal to continue operation during an SLR term does not include construction of additional plant structures that would require decommissioning, and additional workers are not anticipated for the SLR term that would incrementally increase socioeconomic impacts of termination of plant operations. FPL would plan and conduct decommissioning activities in accordance with NRC-reviewed methods and evaluate anticipated environmental impacts to ensure they are bounded by previously issued environmental assessments or are SMALL. No new and significant information has been identified for this issue; therefore, no further analysis is required.

The decommissioning impacts component of this issue was considered in PTN's first license renewal's new and significant review, and no new and significant information was found at that time (FPL 2000b, Table 4.0-2). The GEIS (NRC 2013a) combined several Category 1 decommissioning issues in the 1996 GEIS and added consideration of termination of plant operations.

4.15 Severe Accident Mitigation Alternatives Analysis

The following sections address severe accident mitigation alternatives (SAMAs) analysis applicable to PTN, providing background on the issues and the analyses regarding the SLR period.

In 2000, FPL submitted an application for OL renewal, which was approved in 2002. The original 40-year OLs for PTN were thereby renewed for a period of 20 years. As part of the first license renewal process, a detailed evaluation of potential SAMAs was performed. Of the 169 potential SAMAs identified in the first license renewal, 93 were qualitatively screened from further evaluation (e.g., those that are only applicable to boiling water reactors), and a detailed cost-benefit analysis was performed on the 76 SAMAs that could not be screened (FPL 2000a). The cost-benefit analysis included development of a Level 3 probabilistic risk assessment (PRA) for PTN Unit 3, which was used to calculate conditional offsite population doses and offsite economic consequences for each of the PRA source term categories (STCs). The analysis was developed for Unit 3, and applicable to the license renewal for both units (FPL 2000a). By calculating the reduction in STC frequencies for each potential SAMA, the present value dollar benefit of each was determined, utilizing the guidance of NUREG/BR-0184 (NRC 1997). The benefit was then compared to a cost estimate for each to complete the cost-benefit comparison. The conclusion of the analysis was that none of the proposed SAMAs were cost beneficial to PTN.

As part of the SLRA process to renew the PTN OLs for another 20 years, the PTN PRA was again examined for insights. The purpose was to determine if there was any new and significant information regarding the SAMA analyses that were prepared to support issuance of the initial renewed OLs for PTN. Over the course of plant operation, changes are made to the plant design, operation, and maintenance practices. Periodic updates to the PTN PRA have ensured that the PRA includes the relevant changes and continues to reflect the current plant design and operation. PRA updates also include updates to the plant-specific initiating event and equipment data utilized, and improvements in state-of-the-art analysis of severe accidents. Therefore, the PRA provides valuable insights into the risk significance of the plant changes over time.

The analyses below follow the model approach in NEI 17-04 [Rev. 0] (NEI 2017c), which NEI has submitted for endorsement by the NRC staff for determining whether there is new and significant information regarding the SAMA analyses. For the PTN SLRA, the consideration of new and significant changes since the time of the first license renewal is consistent with the GEIS (NRC 2013a), Supplement 49 (NRC 2014b). Section 5.3.9 of GEIS Supplement 49 states the following:

New information is significant if it provides a seriously different picture of the impacts of the federal action under consideration. Thus, for mitigation alternatives such as SAMAs, new information is significant if it indicates that a mitigation alternative would substantially reduce an impact of the federal action on the environment. Consequently, with respect to SAMAs, new information may be significant if it indicated a given cost-beneficial SAMA would substantially reduce the impacts of a severe accident or the probability or consequences (risk) of a severe accident occurring.

The implication of this statement is that "significance" is not solely related to whether or not a SAMA is cost beneficial, but depends also on a SAMA's potential to significantly reduce risk to the public (NEI 2017c).

4.15.1 Category 1 Issue—Design-Basis Accidents

The following Category 1 issue related to postulated accidents was reviewed for new and significant information that could make the generic finding as described in the GEIS (NRC 2013a) inapplicable to PTN: Issue 65—Design-basis accidents.

The GEIS (NRC 2013a) concluded that because a licensee is required to maintain the plant within acceptable design and performance criteria, including during any license renewal term, impacts from design-basis accidents would not be affected by changes in plant environment because such impacts (1) are based on calculated radioactive releases that are not expected to change; (2) are not affected by plant environment because they are evaluated for the hypothetical maximally exposed individual; and (3) have been previously determined acceptable.

4.15.2 Category 2 Issue—Severe Accidents

The following Category 2 issue (requirement) related to severe accidents has been defined by the NRC in 10 CFR 51.53(c)(3)(ii)(L):

If the staff has not previously considered SAMAs for the applicant's plant in an EIS or related supplement or in an environmental assessment, a consideration of alternatives to mitigate severe accidents must be provided.

The NRC finding regarding severe accidents is stated in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, as follows:

The probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives.

The NRC has ruled that when a plant qualifies for the exception from the requirement to consider SAMAs in 10 CFR 51.53(c)(3)(ii)(L), the exception operates to designate this Category 2 issue as the "functional equivalent" of a Category 1 issue (NRC 2013f). Accordingly, using a review process similar to that used for other Category 1 issues, FPL reviewed this issue for new and significant information that would cause the following generic conclusions in the GEIS (NRC 2013a) concerning this issue to be inapplicable to PTN.

1. The probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are small for all plants.

2. License renewal ERs for plants for which SAMAs have been previously considered need not consider SAMAs.

The subsections below describe the methodology and review for each conclusion.

4.15.3 Methodology for Evaluation of New and Significant SAMAs

4.15.3.1 PTN SLRA SAMA Stage 1 Evaluations—Screening

The evaluations of the PTN SLRA SAMAs are consistent with the NEI 17-04 methodology (NEI 2017c), which describes a three-stage process for determining whether there is any "new and significant" information relevant to a previous SAMA analysis. In Stage 1, the SLRA applicant uses PRA risk insights and/or risk model quantifications to estimate the percent reduction in the maximum benefit (MB) associated with (1) all unimplemented "Phase 2" SAMAs for the analyzed plant and (2) those SAMAs identified as potentially cost beneficial for other U.S. nuclear power plants and which are applicable to the analyzed plant. If one or more of those SAMAs are shown to reduce the MB by 50 percent or more, then the applicant must complete Stage 2 by developing updated averted cost-risk estimates for implementing those SAMAs. If the Stage 2 assessment confirms that one or more SAMAs reduce the MB by 50 percent or more, then the applicant must complete Stage 3 by performing a cost-benefit analysis for the "potentially significant" SAMAs identified in Stage 2. Applicants that are able to demonstrate through the Stage 1 screening process that there is no potentially significant new information are not required to perform the Stage 2 or Stage 3 evaluations. The application of the NEI 17-04 methodology to PTN is described in the following subsections.

4.15.3.1.1 Definitions of New and Significant Information

"New" information pertains to data used in a SAMA analysis that have changed or become available since the time the preceding SAMA analysis was performed.

There are some inputs to the SAMA analysis that are expected to change, or to potentially change, for all plants. These inputs include the following:

- Updated Level 3 PRA model consequence results, which may be impacted by multiple inputs, including, but not limited to, the following:
    - Population, as projected within a 50-mile radius of the plant.
    - Value of farm and non-farm wealth.
    - Core inventory (e.g., due to power uprate).
    - Evacuation timing and speed.
    - Level 3 PRA methodology updates.
- NUREG/BR-0058 (NRC 2004) cost-benefit methodology updates.

In addition, other changes that could be considered "new information" are dependent on plant activities or site-specific changes. These types of changes include the following:

- Identification of a new hazard (e.g., a fault that was not previously analyzed in the seismic analysis).
- Updated plant risk model (e.g., a fire PRA that replaces the individual plant examination of external events [IPEEE] analysis).
    - Impacts of plant changes that are included in the plant risk models will be reflected in the model results and do not need to be assessed separately.

- Non-modeled modifications/changes to the plant.
  - o Modifications determined to have no risk impact need not be included (e.g., replacement of the condenser vacuum pumps), unless they impact a specific input to SAMA (e.g., a new low-pressure turbine in the power conversion system that results in a greater net electrical output).

For risk model updates performed to reflect the latest PRA model state of the practice, it was noted that the actual physical plant risk may not have changed; however, because the best-estimate assessment or understanding of the risk (e.g., plant-specific risk profile) has changed, it was considered to be new information.

The NEI methodology (NEI 2017c) considers a potential SAMA to not be significant unless it reduces the MB, as defined in Section 4.5 of NEI 05-01 [Rev. A], by at least 50 percent. The Stage 1 quantitative screening process evaluates this using the criterion of no STC frequency being reduced by at least 50 percent. Because the MB is the sum total of the contribution of each STC, if no STC decreases by at least 50 percent, then the total MB reduction cannot exceed 50 percent. However, the approach of evaluating every STC is not necessary to ensure the MB reduction is less than 50 percent. In reality, many individual STCs have a frequency that is insignificant, and while an insignificant STC could in theory be reduced by more than 50 percent, its impact on MB would be negligible. Therefore, for this analysis, STC groups (large early release frequency [LERF]; small early release frequency [SERF], etc.) were examined as a whole for percentage reduction. If no STC group frequency was reduced by more than 50 percent, then also the MB would not be reduced by more than 50 percent. Therefore, that SAMA would not be considered potentially significant and would not be evaluated further in assessing the significance of new information.

The quantitative evaluations performed for this analysis use the PTN internal events model for full evaluation of Level 2 STC groups. However, the PTN internal flood and fire models are only capable of quantifying core damage frequency (CDF) and the LERF STC group. PTN does not have a seismic PRA. In 2014, a bounding seismic evaluation was performed for PTN using appropriate seismic hazard curves and a plant-level fragility curve. While the bounding seismic evaluation for PTN was sufficient to demonstrate that seismic risk at PTN is not significant, the nature of the analysis does not lend itself to the detailed evaluations performed for this SLRA.

For consideration of total STC group frequencies being reduced by more than 50 percent, detailed calculations are performed for the internal events STC group and for fire/flood LERF (CDF was also quantified). The fire/flood LERF and CDF calculations provide confidence that their impact from each SAMA is consistent with the internal events calculations, and that the MB would not be reduced by more than 50 percent for any of the SAMAs evaluated. Since PTN does not have a seismic PRA, its impact is considered represented by the internal events analyses. Because the Stage 1 analysis evaluates percentage (and not absolute value) reduction in MB, the percentage reduction in seismic would be consistent with internal events and fire. In terms of internal floods and external event consideration, the percentage reduction in total MB is comparable or conservatively represented by utilizing the internal events models. The flood and fire models utilize the logic from the Level 1 PRA event trees. Most fire and seismic significant contributors would utilize the sequence logic of loss of offsite power (LOOP) and/or station blackout (SBO) events. Therefore, the percentage reduction in MB achieved by each SAMA would be similar to that of the internal events LOOP and SBO analyses. While this would yield some change to the specific contribution on each STC group, the changes are not expected to be significant because of the use of the same supporting event tree logic.

It is also important to note that the FPL internal events model receives a significant contribution to LERF (and also MB) from interfacing systems loss-of-coolant accident (ISLOCA) (19 percent of total internal events MB). The external events analysis, however, does not have any contribution from ISLOCA initiating events. Since ISLOCA events have a significant contribution to the overall MB, this reduces the relative contribution from external events.

Regarding new information about changes in population near the PTN site and changes in methodology (e.g., dollar/person-rem estimates), there are some changes since the first PTN license renewal and SAMA analysis. However, compared to the greater than a factor of 20 decrease in the absolute value of internal events CDF at PTN, the other changes are small. Specifically, the PTN model used to evaluate the SAMA in the initial LRA had an internal events CDF of approximately 1.6E-5/year. The current model of record has a CDF of approximately 7.0E-7/year for each unit.

4.15.4 Analysis

4.15.4.1 Identification and Screening

The list of candidate SAMAs for the PTN SLRA was developed from plant-specific and industry sources. For the plant-specific portion, the first PTN license renewal SAMA evaluation was examined to identify all SAMAs that could not be qualitatively screened, and they were found not to be cost effective. Evaluating these items was appropriate for determining if there was any new and significant information for PTN and the PRA since the time of the first license renewal in regard to the potential plant improvements.

The GEIS (NRC 2013a) includes the SEISs that licensees were required to prepare to address potential environmental impacts and mitigation measures for 23 issues requiring plant-specific review. Potentially cost-beneficial SAMAs were identified by licensees as part of this review and are documented in these plant-specific supplements. As PTN has a large, dry pressurized water reactor containment, the scope of the search was limited to these designs.

The list of SAMAs collected was evaluated qualitatively to screen from further evaluation any SAMAs not applicable to PTN, or that already have been implemented at PTN. In addition, one other screening criterion was applied to eliminate SAMAs that have excessive implementation costs. Specifically, SAMAs were screened from further consideration if they were found to reduce the PTN MB by greater than 50 percent in the first PTN license renewal, but nonetheless were found not to be cost effective due to their high estimated costs of implementation in the first LRA and the related NRC SEIS.

The remaining SAMAs were then grouped based on similarities in mitigation equipment or risk-reduction benefits, and all were evaluated for the impact they would have on the PTN STC group frequencies, assuming those SAMAs were implemented at PTN. If any of the SAMAs were found to reduce at least one STC group frequency by at least 50 percent, then the SAMA would retained for a full Level 3 PRA evaluation of the reduction in MB.

4.15.4.2 Stage 1 Screening Evaluation

Industry internal event and external event SAMAs were collected for evaluation in the PTN SLRA. The total number of PTN-specific SAMAs considered was 76. The total number of industry SAMAs considered was 263. Qualitative screening of each from further analysis resulted in elimination of all external event SAMAs in the PTN SLRA. Qualitative screening of the internal events SAMAs, along with binning of similar SAMAs, reduced the total number of SAMAs requiring further evaluation to 13. The binning of SAMAs was performed in a manner that allowed bounding cases that completely addressed a plant risk contributor to be defined to estimate the maximum possible benefits for any of the grouped SAMAs. For example, all ISLOCA-related SAMAs could be represented by a single case in which all ISLOCA events are set to zero (i.e., the risk of an ISLOCA event was assumed to be completely eliminated by SAMA implementation). This bounding approach ensured a conservative analysis, while limiting the total number of cases requiring more detailed evaluation.

Table 4.15-1 presents the industry internal events SAMAs, combined with the PTN-specific SAMAs selected for quantitative screening analysis. "Quantitative screening" refers to the methodology described in preceding sections and was performed using the full internal events Level 2 PRA and the CDF/LERF portions of the fire and flood PRAs. Specifically, SAMAs are quantitatively screened if the bounding PTN-specific case yields a reduction of less than 50 percent in the frequency of each STC group.

The first column presents a number assigned to each SAMA for tracking purposes. The second column is a case identifier. The third column provides a summary description of each potential SAMA; the fourth column provides the results of the quantitative screening evaluation of the STC group frequencies, and the fifth column presents a summary assessment the screening. As presented in Section 4.15.4.1, the criterion for quantitative screening from further evaluation in the Stage 1 evaluation was that the SAMA does not reduce any STC group frequency by at least 50 percent.

After performing the qualitative and quantitative Stage 1 screening, all potential SAMAs were screened from further evaluation. Therefore, Stage 2 of the NEI methodology was not entered, and an update of the PTN Level 3 PRA was not required.

4.15.5 Conclusions

Based on the Phase 1 qualitative and quantitative screening results, all plant-specific and industry SAMAs were demonstrated to not be new and significant.

Therefore, it is concluded that there is no new and significant information that would alter the conclusions of the original SAMA analysis for PTN.

Table 4.15-1
Quantitative Screening of SAMAs that were not Qualitatively Screened (Sheet 1 of 9)

#	Case Name	Description of Bounding Case	Results				Notes
			Internal Events[a]	**Base Model Results**	**Case 1**	**% Change**	
1	HHSI-PMP	The case represents an additional high pressure safety injection pump with independent pump failures (fails to start, fails to run, pump in test and maintenance (T&M), failure to restore pump from T&M) and failures in high pressure safety injection discharge header and suction header.	CDF (ALLTOPS)	6.97E-07	5.76E-07	-17.36	All internal events STC group frequencies were reduced by less than 50 percent. Fire and flood CDF and LERF were reduced by less than 50 percent.
			INTACT–TOTAL	3.62E-07	3.27E-07	-9.67	
			LATE–TOTAL	4.20E-07	3.23E-07	-23.10	
			LERF–TOTAL	1.47E-08	1.38E-08	-6.12	
			SERF–TOTAL	8.17E-09	7.98E-09	-2.33	
			Fire				
			CDF (ALLTOPS)	5.82E-05	5.33E-05	-8.42	
			LERF–TOTAL	4.60E-06	4.57E-06	-0.65	
			Flood				
			CDF (ALLTOPS)	1.62E-07	1.62E-07	0.00	
			LERF–TOTAL	8.36E-10	8.36E-10	0.00	

Table 4.15-1
Quantitative Screening of SAMAs that were not Qualitatively Screened (Sheet 2 of 9)

#	Case Name	Description of Bounding Case	Results				Notes
2	EDG	An additional EDG is modeled via setting independent failures (failure to run [FR], failure to start [FS], T&M) for one of the Unit 3 EDGs to a very small value.	**Internal Events[(a)]**	**Base Model Results**	**Case 2**	**% Change**	All internal events STC group frequencies were reduced by less than 50 percent. Fire and flood CDF and LERF were reduced by less than 50 percent.
			CDF (ALLTOPS)	6.97E-07	6.93E-07	-0.57	
			INTACT–TOTAL	3.62E-07	3.62E-07	0.00	
			LATE–TOTAL	4.20E-07	4.15E-07	-1.19	
			LERF–TOTAL	1.47E-08	1.47E-08	0.00	
			SERF–TOTAL	8.17E-09	8.17E-09	0.00	
			Fire				
			CDF (ALLTOPS)	5.82E-05	5.81E-05	-0.17	
			LERF–TOTAL	4.60E-06	4.59E-06	-0.22	
			Flood				
			CDF (ALLTOPS)	1.62E-07	1.62E-07	0.00	
			LERF–TOTAL	8.36E-10	8.36E-10	0.00	
3	RECIRC-SWAP	Remove operator failure [for recirc swap].	**Internal Events[(a)]**	**Base Model Results**	**Case 3**	**% Change**	All internal events STC group frequencies were reduced by less than 50 percent. Fire and flood CDF and LERF were reduced by less than 50 percent.
			CDF (ALLTOPS)	6.97E-07	6.65E-07	-4.59	
			INTACT–TOTAL	3.62E-07	3.29E-07	-9.12	
			LATE–TOTAL	4.20E-07	4.14E-07	-1.43	
			LERF–TOTAL	1.47E-08	1.47E-08	0.00	
			SERF–TOTAL	8.17E-09	8.17E-09	0.00	
			Fire				
			CDF (ALLTOPS)	5.82E-05	5.71E-05	-1.89	
			LERF–TOTAL	4.60E-06	4.57E-06	-0.65	
			Flood				
			CDF (ALLTOPS)	1.62E-07	1.62E-07	0.00	
			LERF–TOTAL	8.36E-10	8.36E-10	0.00	

Table 4.15-1
Quantitative Screening of SAMAs that were not Qualitatively Screened (Sheet 3 of 9)

#	Case Name	Description of Bounding Case	Results				Notes
4	AFW-PMP	A redundant auxiliary feedwater (AFW) pump with independent pump failures and 2 support systems (water supply and steam supply) is added.	**Internal Events[(a)]**	**Base Model Results**	**Case 4**	**% Change**	All internal events STC group frequencies were reduced by less than 50 percent. Fire and flood CDF and LERF were reduced by less than 50 percent.
			CDF (ALLTOPS)	6.97E-07	6.16E-07	-11.62	
			INTACT–TOTAL	3.62E-07	2.88E-07	-20.44	
			LATE–TOTAL	4.20E-07	3.93E-07	-6.43	
			LERF–TOTAL	1.47E-08	1.12E-08	-23.81	
			SERF–TOTAL	8.17E-09	8.17E-09	0.00	
			Fire				
			CDF (ALLTOPS)	5.82E-05	3.98E-05	-31.62	
			LERF–TOTAL	4.60E-06	2.68E-06	-41.74	
			Flood				
			CDF (ALLTOPS)	1.62E-07	1.62E-07	0.00	
			LERF–TOTAL	8.36E-10	8.30E-10	-0.72	
5	H2-CONT	Set all hydrogen (H2)-induced containment failure to zero.	**Internal Events[(a)]**	**Base Model Results**	**Case 5**	**% Change**	All internal events STC group frequencies were reduced by less than 50 percent. Fire and flood CDF and LERF were reduced by less than 50 percent.
			CDF (ALLTOPS)	6.97E-07	6.97E-07	0.00	
			INTACT–TOTAL	3.62E-07	3.63E-07	0.28	
			LATE–TOTAL	4.20E-07	4.20E-07	0.00	
			LERF–TOTAL	1.47E-08	1.42E-08	-3.40	
			SERF–TOTAL	8.17E-09	8.17E-09	0.00	
			Fire				
			CDF (ALLTOPS)	5.82E-05	5.82E-05	0.00	
			LERF–TOTAL	4.60E-06	4.53E-06	-1.52	
			Flood				
			CDF (ALLTOPS)	1.62E-07	1.62E-07	0.00	
			LERF–TOTAL	8.36E-10	6.26E-10	-25.12	

Table 4.15-1
Quantitative Screening of SAMAs that were not Qualitatively Screened (Sheet 4 of 9)

#	Case Name	Description of Bounding Case	Results				Notes
6	CISO	Set containment isolation failure to zero.	**Internal Events[(a)]**	**Base Model Results**	**Case 6**	**% Change**	All internal events STC group frequencies were reduced by less than 50 percent. Fire CDF and LERF were reduced by less than 50 percent. Reduction in internal flooding LERF was 71 percent. However, the absolute value of internal flooding LERF is only 2.40E-10/year, compared to the internal events and fire LERF that are several orders of magnitude larger and only show a reduction in the LERF group of 9.9 percent and 8.3 percent, respectively. Therefore, the flood contribution is negligible, and the total reduction of the LERF STC group for this case is well below 50 percent.
			CDF (ALLTOPS)	6.97E-07	6.97E-07	0.00	
			INTACT–TOTAL	3.62E-07	3.62E-07	0.00	
			LATE–TOTAL	4.20E-07	4.20E-07	0.00	
			LERF–TOTAL	1.47E-08	1.32E-08	-9.91	
			SERF–TOTAL	8.17E-09	8.17E-09	0.00	
			Fire				
			CDF (ALLTOPS)	5.82E-05	5.82E-05	0.00	
			LERF–TOTAL	4.60E-06	4.22E-06	-8.26	
			Flood				
			CDF (ALLTOPS)	1.62E-07	1.62E-07	0.00	
			LERF–TOTAL	8.36E-10	2.40E-10	-71.29	

Table 4.15-1
Quantitative Screening of SAMAs that were not Qualitatively Screened (Sheet 5 of 9)

#	Case Name	Description of Bounding Case	Results				Notes
			Internal Events[a]	**Base Model Results**	**Case 7**	**% Change**	
7	NO-SGTR	Set steam generator tube rupture (SGTR) events to zero.	CDF (ALLTOPS)	6.97E-07	6.89E-07	-1.15	All internal events STC group frequencies were reduced by less than 50 percent. Fire and flood CDF and LERF were reduced by less than 50 percent.
			INTACT–TOTAL	3.62E-07	3.62E-07	0.00	
			LATE–TOTAL	4.20E-07	4.20E-07	0.00	
			LERF–TOTAL	1.47E-08	1.46E-08	-0.88	
			SERF–TOTAL	8.17E-09	0.00E+00	(only SGTR initiating events)	
			Fire				
			CDF (ALLTOPS)	5.82E-05	NA	NA	
			LERF–TOTAL	4.60E-06	NA	NA	
			Flood				
			CDF (ALLTOPS)	1.62E-07	NA	NA	
			LERF–TOTAL	8.36E-10	NA	NA	

Table 4.15-1
Quantitative Screening of SAMAs that were not Qualitatively Screened (Sheet 6 of 9)

#	Case Name	Description of Bounding Case	Results				Notes
8	ISLOCA		**Internal Events[a]**	**Base Model Results**	**Case 8**	**% Change**	All internal events STC group frequencies were reduced by less than 50 percent. Fire and flood CDF and LERF were reduced by less than 50 percent.
			CDF (ALLTOPS)	6.97E-07	6.95E-07	-0.29	
			INTACT–TOTAL	3.62E-07	3.62E-07	0.00	
			LATE–TOTAL	4.20E-07	4.20E-07	0.00	
			LERF–TOTAL	1.47E-08	1.19E-08	-18.84	
			SERF–TOTAL	8.17E-09	8.17E-09	0.00	
			Fire				
			CDF (ALLTOPS)	5.82E-05	5.82E-05	0.00	
			LERF–TOTAL	4.60E-06	4.60E-06	0.00	
			Flood				
			CDF (ALLTOPS)	1.62E-07	1.62E-07	0.00	
			LERF–TOTAL	8.36E-10	8.36E-10	0.00	
9	AIR-SYS	Set instrument air compressor basic events to zero.	**Internal Events[a]**	**Base Model Results**	**Case 9**	**% Change**	All internal events STC group frequencies were reduced by less than 50 percent. Fire and flood CDF and LERF were reduced by less than 50 percent.
			CDF (ALLTOPS)	6.97E-07	6.97E-07	0.00	
			INTACT–TOTAL	3.62E-07	3.62E-07	0.00	
			LATE–TOTAL	4.20E-07	4.20E-07	0.00	
			LERF–TOTAL	1.47E-08	1.47E-08	0.00	
			SERF–TOTAL	8.17E-09	8.17E-09	0.00	
			Fire				
			CDF (ALLTOPS)	5.82E-05	5.82E-05	0.00	
			LERF–TOTAL	4.60E-06	4.60E-06	0.00	
			Flood				
			CDF (ALLTOPS)	1.62E-07	1.62E-07	0.00	
			LERF–TOTAL	8.36E-10	8.36E-10	0.00	

Table 4.15-1
Quantitative Screening of SAMAs that were not Qualitatively Screened (Sheet 7 of 9)

#	Case Name	Description of Bounding Case	Results				Notes
10	CONT-SPRAY	Add an independent containment spray pump.	**Internal Events[(a)]**	**Base Model Results**	**Case 10**	**% Change**	All internal events STC group frequencies were reduced by less than 50 percent. Fire and flood CDF and LERF were reduced by less than 50 percent.
			CDF (ALLTOPS)	6.97E-07	6.97E-07	0.00	
			INTACT–TOTAL	3.62E-07	3.72E-07	2.76	
			LATE–TOTAL	4.20E-07	4.12E-07	-1.90	
			LERF–TOTAL	1.47E-08	1.48E-08	0.68	
			SERF–TOTAL	8.17E-09	8.17E-09	0.00	
			Fire				
			CDF (ALLTOPS)	5.82E-05	5.82E-05	0.00	
			LERF–TOTAL	4.60E-06	4.60E-06	0.00	
			Flood				
			CDF (ALLTOPS)	1.62E-07	1.62E-07	0.00	
			LERF–TOTAL	8.36E-10	8.36E-10	0.00	
11	NO-ATWS	Eliminate all anticipated transients without scram (ATWS) events to bound benefit.	**Internal Events[(a)]**	**Base Model Results**	**Case 11**	**% Change**	All internal events STC group frequencies were reduced by less than 50 percent. Fire and flood CDF and LERF were reduced by less than 50 percent.
			CDF (ALLTOPS)	6.97E-07	6.34E-07	-9.04	
			INTACT–TOTAL	3.62E-07	2.95E-07	-18.51	
			LATE–TOTAL	4.20E-07	4.08E-07	-2.86	
			LERF–TOTAL	1.47E-08	1.22E-08	-17.01	
			SERF–TOTAL	8.17E-09	8.17E-09	0.00	
			Fire				
			CDF (ALLTOPS)	5.82E-05	5.82E-05	0.00	
			LERF–TOTAL	4.60E-06	4.60E-06	0.00	
			Flood				
			CDF (ALLTOPS)	1.62E-07	1.61E-07	-0.62	
			LERF–TOTAL	8.36E-10	8.11E-10	-2.99	

Table 4.15-1
Quantitative Screening of SAMAs that were not Qualitatively Screened (Sheet 8 of 9)

#	Case Name	Description of Bounding Case	Results				Notes
12	NO-MSLB	Eliminate the main steam line break (MSLB) initiating events.	**Internal Events[(a)]**	**Base Model Results**	**Case 12**	**% Change**	All internal events STC group frequencies were reduced by less than 50 percent. Fire and flood CDF and LERF were reduced by less than 50 percent.
			CDF (ALLTOPS)	6.97E-07	6.84E-07	-1.87	
			INTACT–TOTAL	3.62E-07	3.48E-07	-3.87	
			LATE–TOTAL	4.20E-07	4.17E-07	-0.71	
			LERF–TOTAL	1.47E-08	1.43E-08	-2.72	
			SERF–TOTAL	8.17E-09	8.17E-09	0.00	
			Fire				
			CDF (ALLTOPS)	5.82E-05	NA	NA	
			LERF–TOTAL	4.60E-06	NA	NA	
			Flood				
			CDF (ALLTOPS)	1.62E-07	NA	NA	
			LERF–TOTAL	8.36E-10	NA	NA	

Table 4.15-1
Quantitative Screening of SAMAs that were not Qualitatively Screened (Sheet 9 of 9)

#	Case Name	Description of Bounding Case	Results				Notes
13	NO-LLOCA	Eliminate the large LOCA initiating event.	**Internal Events[a]**	**Base Model Results**	**Case 13**	**% Change**	All internal events STC group frequencies were reduced by less than 50 percent. Fire and flood CDF and LERF were reduced by less than 50 percent.
			CDF (ALLTOPS)	6.97E-07	6.96E-07	-0.14	
			INTACT–TOTAL	3.62E-07	3.61E-07	-0.28	
			LATE–TOTAL	4.20E-07	4.19E-07	-0.24	
			LERF–TOTAL	1.47E-08	1.47E-08	0.00	
			SERF–TOTAL	8.17E-09	8.17E-09	0.00	
			Fire				
			CDF (ALLTOPS)	5.82E-05	NA	NA	
			LERF–TOTAL	4.60E-06	NA	NA	
			Flood				
			CDF (ALLTOPS)	1.62E-07	NA	NA	
			LERF–TOTAL	8.36E-10	NA	NA	

a. CDF (ALLTOPS): core damage frequency (all internal events)
INTACT–TOTAL: total frequency of intact containment end states
LATE–TOTAL: total frequency of late containment failure end states
LERF–TOTAL: total frequency of large, early release containment failure end states
SERF–TOTAL: total frequency of small, early release containment failure end states

5.0 ASSESSMENT OF NEW AND SIGNIFICANT INFORMATION

> The environmental report must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware. [10 CFR 51.53(c)(3)(iv)]

The NRC has resolved most license renewal environmental issues generically and requires an applicant to analyze only those issues the NRC has not resolved generically. While NRC regulations do not require an applicant's ER to contain analyses of the impacts of those Category 1 environmental issues that have been generically resolved [10 CFR 51.53(c)(3)(i)], the regulations do require that an applicant identify any new and significant information of which the applicant is aware. [10 CFR 51.53(c)(3)(iv)]

5.1 New and Significant Information Discussion

The NRC provides guidance on new and significant information in Regulatory Guide 4.2, Supplement 1, Revision 1 (NRC 2013b). In this guidance, new and significant information is defined as follows:

1. Information that identifies a significant environmental impact issue that was not considered or addressed in the GEIS and, consequently, not codified in Table B-1, "Summary of Findings on NEPA Issues for License Renewal of Nuclear Plants," in Appendix B, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," to Subpart A, "National Environmental Policy Act—Regulations Implementing Section 102(2)," of 10 CFR Part 51;

2. Information not considered in the assessment of impacts evaluated in the GEIS leading to a seriously different picture of the environmental consequences of the action than previously considered, such as an environmental impact finding different from that codified in Table B-1; or

3. Any new activity or aspect associated with the nuclear power plant that can act upon the environment in a manner or an intensity and/or scope (context) not previously recognized.

Based on available guidance and the definitions of SMALL, MODERATE, and LARGE impacts provided by NRC in 10 CFR Part 51, Appendix B, Table B-1, Footnote 3, FPL expects that any new information regarding Category 1 issues with moderate or large impacts would be significant. Section 4.0.2 presents the NRC definitions of SMALL, MODERATE, and LARGE impacts.

5.2 New and Significant Information Review Process

FPL's new and significant information assessment process outlined in the following discussion was designed to meet the guidance in the regulatory guide noted above.

FPL's process is collectively carried out through its ongoing environmental planning, assessment, monitoring, and compliance activities performed by corporate and PTN management and staff and ER-specific reviews. This team has collective knowledge of the license renewal process, the site, licensing and permitting, environmental issues, the first license renewal of PTN, the NEPA process, and nuclear industry activities. The team implemented the in-house process for reviewing and evaluating environmental issues that could potentially be new and significant information.

FPL's new and significant review included establishment of applicable and non-applicable Category 1 issues through the following:

- Review of the FPL first license renewal ER (FPL 2000a), the related NRC SEIS (NRC 2002a), and the GEIS Category 1 issues discussion (NRC 2013a).
- Review of recent publicly available information, or information held by the applicant, related to the resource area and each applicable Category 1 impact issue, as summarized in the appropriate section of Chapter 3.
- Identification and review of modifications to PTN since the most recent licensing environmental review and, if any, those anticipated during the proposed SLR operating period, including refurbishment. However, no license renewal-related refurbishment activities have been identified.
- Identification and assessment of potential changes in environmental interfaces since the most recent environmental review and those anticipated during the proposed license renewal period.

FPL applied an investigative process for purposely seeking new information related to the Category I environmental issues through the following:

- Environmental review team discussions with FPL subject matter experts on the Category 1 issues as they relate to the plant.
- Review of permits and reference materials listed in Table 9.1-1 and Chapter 1 related to regulatory compliance status of the plant, environmental issues at the plant, and the environmental resource areas related to Category 1 issues.
- Review of environmental monitoring and reporting required by regulations.

- Review of FPL environmental programs and procedures.
- Review of correspondence and permitting documentation related to oversight of Turkey Point facilities and operations by state and federal regulatory agencies (permanent activities that would bring significant issues to the plant's attention) for the agencies' roles in identifying site-specific environmental concerns.
- Review of previous LRAs for issues relevant to the PTN application.
- Review of previous licensing actions at the Turkey Point site, including but not limited to the PTN Units 3 and 4 EPU and the Turkey Point Units 6 and 7 COL application.
- Review of the environmental assessment for the 2014 UHS amendment and the related licensing board order.

In addition, FPL is made aware of and stays abreast of new and emerging environmental issues and concerns on an ongoing basis through the following:

- Review of other LRAs and nuclear industry publications and participation in nuclear industry organizations.
- Involvement in the recent Turkey Point Units 6 and 7 COL application and NRC reviews.
- Contact with state and federal agencies with regulatory jurisdiction over environmental regulation.
- Review of correspondence and permitting documentation and discussions related to oversight of PTN facilities and operations by state and federal regulatory agencies in their role in identifying site-specific environmental concerns.
- Development and periodic review of regulatory guidance procedures that address ongoing and emergent issues.

Information resulting from the information-seeking process was assessed to determine if it is new, applying the following considerations:

- Was the information included in or available for the GEIS analysis of the Category 1 issue?
- Was the information included in or available for the SEIS for PTN first license renewal?

The following considerations were applied to determine significance:

- Does the information identify an environmental issue not generically considered in the GEIS and consequently not codified in 10 CFR 51, Appendix B, Table B-1?
- Does the information present a seriously different picture of the environmental consequences of the action than previously considered, leading to an impact finding different (i.e., MODERATE or LARGE) from that included in the GEIS or codified in regulation?
- Does the information involve a new activity or aspect associated with the nuclear power plant that can act upon the environment in a manner or an intensity (MODERATE or LARGE impact) and/or scope (context) not previously recognized?

As a result of this review, FPL is aware of no new and significant information regarding the environmental impacts of license renewal associated with PTN. Therefore, the findings in NUREG-1437, Revision 1, for the applicable Category 1 issues are incorporated by reference.

New and significant review methodology and results for the SAMA evaluation are addressed separately in Section 4.15.

9.0 STATUS OF COMPLIANCE

The ER shall list all federal permits, licenses, approvals, and other entitlements which must be obtained in connection with the proposed action and shall describe the status of compliance with these requirements. The ER shall also include a discussion of the status of compliance with applicable environmental quality standards and requirements including, but not limited to, applicable zoning and land-use regulations, and thermal and other water pollution limitations or requirements which have been imposed by federal, state, regional, and local agencies having responsibility for environmental protection. [10 CFR 51.45(d)]

9.1 PTN Authorizations

Table 9.1-1 provides a summary of authorizations held by PTN for current plant operations. Authorizations in this context include any permits, licenses, approvals, or other entitlements that would continue to be in place, as appropriate, throughout the period of extended operation given their respective renewal schedules. Table 9.1-2 lists additional environmental authorizations and consultations related to the renewal of the PTN site. FPL routinely interacts with stakeholders and will notify the appropriate state and local agencies to inform them of the proposed action.

Table 9.1-1
Environmental Authorizations for Current PTN Operations (Sheet 1 of 7)

Agency	Authority	Requirement	Number	Expiration Date	Authorized Activity
CILLRWC	Omnibus Low-Level Radioactive Waste Interstate Compact Consent Act (1980; amended in 1985)	Authorization to export waste	None	Updated annually	Export of LLRW outside the region.
EPA & FDEP	Clean Water Act Section 401 [33 USC 1341]	Certification of state water quality standards	PA 03-45E	Final conditions of certification issued 3/29/2016	Discharges during license renewal term.
FAA	14 CFR Part 77 – Safe, Efficient Use, and Preservation of Navigable Airspace	FAA obstruction permit for Units 3 and 4	2009-ASO-4096-OE and 2009-ASO-4094-OE	N/A; pre-construction coordination	FAA obstruction permit for Units 3 and 4.
NRC	10 CFR 72	General license for storage of spent fuel at power reactor sites	General permit	N/A	Storage of power reactor spent fuel and other associated radioactive materials in an ISFSI.
NRC	Atomic Energy Act 10 CFR 50	Licensing of nuclear power plant	DPR-31	7/19/2032	Operation of Unit 3.
NRC	Atomic Energy Act 10 CFR 50	Licensing of nuclear power plant	DPR-41	4/10/2033	Operation of Unit 4.
US District Court	Clean Water Act	Consent decree	70-328-CA	N/A	IWW Construction, Operation, and Maintenance.

Table 9.1-1
Environmental Authorizations for Current PTN Operations (Sheet 2 of 7)

Agency	Authority	Requirement	Number	Expiration Date	Authorized Activity
USDOT	40 CFR 107 Subpart G	Registration	060911 551 091T	None	Hazardous materials shipments.
USACE & FDEP	Clean Water Act of 1976	Section 401/404 permit	Pending	Permit pending	Discharge of dredge and fill materials into waters of the U.S. (Turtle Point and Barge Terminal).
USACE & FDEP	Clean Water Act Section 401 [33 USC 1341]	Certification of State Water Quality Standards	FL0001562 (Section I.E. 15)	Under agency review	Discharges during license renewal term
USACE & FDEP	Resource Conservation and Recovery Act (RCRA) 42 USC 6901	Hazardous waste generator number	FLR000192922	N/A	Small Quantity Hazardous Waste Generator
USFWS	16 USC 1539(a)(1)(A) 50 CFR Parts 13, 17	Endangered species permit to take American crocodile during monitoring	TE092945-2	4/20/2018	Provides authorization to take (capture, examine, weigh, sex, collect tissue samples, mark, radio-tag, radio-track, relocate, release) endangered American crocodile individuals during population monitoring.

Table 9.1-1
Environmental Authorizations for Current PTN Operations (Sheet 3 of 7)

Agency	Authority	Requirement	Number	Expiration Date	Authorized Activity
USFWS	16 USC 703-712	Migratory bird special purpose utility permit	MB697722-0	3/31/2018	Authorizes utilities to collect, transport and temporarily possess migratory birds found dead on utility property, structures, and ROWs for avian mortality monitoring or disposal purposes.
USFWS	Biological Opinion	Effects of operation on the on the endangered American crocodile	41420-2006-FA-0478; 41420-2006-F-0125	Perpetual	Plan to minimize the potential adverse effects of ongoing operations of PTN to the American crocodile.
State of Florida Authorizations					
FDEP Siting Board	FS 403.501-.518	Power plant site certification	PA 03-45E	Final conditions of certification issued 3/29/2016	Construction and operation of a power plant with more than 75 MW of steam generated power and associated facilities.
SFWMD	Fifth Supplemental Agreement	Power plant site certification	N/A	N/A	Implementation of new monitoring plan that includes groundwater, surface water, and ecological monitoring in and around the Turkey Point CCS.

Table 9.1-1
Environmental Authorizations for Current PTN Operations (Sheet 4 of 7)

Agency	Authority	Requirement	Number	Expiration Date	Authorized Activity
FDEP	403.087, FS and FAC 62-4, 62-520, 62-522, 62-528, 62-550, 62-600, 62-601	Operation of Class V, Group 3 domestic wastewater injection (gravity flow) well	0127512-006-UO	Issued 8/14/2012	Operation of IW-1.
FDEP	FAC 62-213	Title V operations permit	025003-021-AV	12/31/2018 Final conditions of certification issued 3/29/ 2016.	Operation of facilities that generate air emissions.
FDEP	FAC Chapters 62-600, 62-601, 62-602, 62-620, 62-640 and 62-699 and Florida Statute Chapter 403	Operation of domestic wastewater treatment facility	FLA013612-003-DW3P	Under agency review	Operation of PTN wastewater treatment facility.
FDEP	Rule 62-620.610(11) FAC; Rule 62-620.340 FAC; Rule 62-620.610(14) FAC	Domestic wastewater	FLA013612 002-DW3P	Under agency review	Discharges during license renewal term.
FDEP	Florida Statutes Chapter 376	Annual storage tank registration	Facility ID: 8622249 Placard No.: 110600	Annual renewal	Operation of above-ground storage tanks.

Table 9.1-1
Environmental Authorizations for Current PTN Operations (Sheet 5 of 7)

Agency	Authority	Requirement	Number	Expiration Date	Authorized Activity
FDEP	Florida Statutes Chapter 377	Annual storage tank registration	Facility ID: 8622251 Placard No.: 110599	Annual renewal	Operation of above-ground storage tanks.
FDEP	Rule 62-620.610(11) FAC; Rule 62-620.340 FAC; Rule 62-620.610(14) FAC	Domestic wastewater annual operating permit	0127512-002-UO	Final conditions of certification issued 3/29/2016	Operation of a domestic wastewater injection well.
FFWCC	FAC 68A-9.002, 68A-27.004	Migratory bird nest removal	LSNR-11-00026C	Annual renewal	Authorization to remove and replace inactive nests of migratory birds.
FFWCC	FAC 68A-9.002, 68A-27.005	Scientific collection permit	LSNR-11-00021B	4/20/18	Scientific collection.
Florida Forest Service	Turkey Point Monitoring Plan (effective 10/12/2009)	Burn permit	1373489	No expiration	Authorization for open fires.
Other States' Authorizations					
Utah Department of Environmental Quality Division of Radiation Control	R313-26 of the Utah Radiation Control Rules	Revision of existing general site access permit		Annual authorization	Transport of radioactive materials into the State of Utah.

Table 9.1-1
Environmental Authorizations for Current PTN Operations (Sheet 6 of 7)

Agency	Authority	Requirement	Number	Expiration Date	Authorized Activity
Tennessee Department of Environment and Conservation Division of Radiological Health	TDEC Rule 1200-2-10.32	Revision of existing Tennessee radioactive waste license for delivery		Annual authorization	Transport of radioactive waste into the State of Tennessee.
Local Authorizations					
MDC DERM	Section 24-18(A)17 Code of Miami-Dade County	Stratospheric ozone protection annual operations permit	APCF-001747-2017/2018	Annual renewal	Use of refrigerants R-12, R-22, R-502 for Robinair Recovery Units, Models 25200, 25200A, 25200B.
MDC DERM	40 CFR 403; Section 24-42.4 Code of Miami-Dade County	Domestic wastewater annual operating permit	DWO-000010-2017/2018	April 14, 2018 Annual renewal	Stabilization treatment facility.
MDC DERM	41 CFR 403; Section 24-42.4 Code of Miami-Dade County	Industrial waste annual operations permit	IW-000003-2017/2018	Annual renewal	Onsite disposal of Class III industrial solid waste consisting of earth and earth-like products, concrete, rock, bricks, and land clearing debris.
MDC DERM	42 CFR 403; Section 24-42.4 Code of Miami-Dade County	IW5 permit (or waiver)	IW-000016-2017/2018	Annual renewal	Hazardous materials or hazardous waste-, large user or generator.

Table 9.1-1
Environmental Authorizations for Current PTN Operations (Sheet 7 of 7)

Agency	Authority	Requirement	Number	Expiration Date	Authorized Activity
MDC DERM	43 CFR 403; Section 24-42.4 Code of Miami-Dade County	Operation of pollution control facility permit	IW5-006229-2017/2018	Annual renewal	Operation of fleet vehicle maintenance facility that generates waste oil, coolant, and used batteries with a solvent wash tank and served by septic tank.
MDC DERM	Chapter 24, Code of Miami-Dade County	Research permit on MDC DERM environmentally endangered lands	2011	6/17/2017	Authorization to conduct ecological monitoring on county-owned environmentally endangered lands.

CFR: Code of Federal Regulations
CILLRWC: Central Interstate Low-Level Radioactive Waste Commission
DOE: U.S. Department of Energy
FAA: Federal Aviation Administration
FAC: Florida Administrative Code
FDEP: Florida Department of Environmental Protection
FFWCC: Florida Fish and Wildlife Conservation Commission
FWS: U.S. Fish and Wildlife Service
MDC DERM: Miami-Dade County Department of Environmental Resources Management
NPS: National Park Service
NRC: U.S. Nuclear Regulatory Commission
SFWMD: South Florida Water Management District
USACE: U.S. Army Corps of Engineers
USDOT: U.S. Department of Transportation

Table 9.1-2
Environmental Authorizations and Consultations for PTN License Renewal

Agency	Authority	Requirement	Remarks
U.S. Nuclear Regulatory Commission	Atomic Energy Act [42 USC 2011 et seq.]	License renewal	Applicant for federal license must submit an ER in support of license renewal application.
U.S. Fish and Wildlife Service	Endangered Species Act Section 7 [16 USC 1636]	Consultation	Requires federal agency issuing a license to consult with the USFWS, and NMFS if applicable, regarding federally protected species.
National Marine Fisheries Service	Endangered Species Act Section 7 [16 USC 1636]	Consultation	Requires federal agency issuing a license to consult with the USFWS, and NMFS if applicable, regarding federally protected species.
Florida Department of State Historic Preservation Office	National Historic Preservation Act Section 106	Consultation	Requires federal agency issuing a license to consider cultural impacts and consult with SHPO and/or tribal historic preservation officer.
Miccosukee Tribe of Indians of Florida	National Historic Preservation Act Section 106	Consultation	Requires federal agency issuing a license to consider cultural impacts and consult with SHPO and/or tribal historic preservation officer.
Poarch Band of Creek Indians	National Historic Preservation Act Section 106	Consultation	Requires federal agency issuing a license to consider cultural impacts and consult with SHPO and/or tribal historic preservation officer.
Seminole Tribe of Florida	National Historic Preservation Act Section 106	Consultation	Requires federal agency issuing a license to consider cultural impacts and consult with SHPO and/or tribal historic preservation officer.
The Choctaw Nation of Oklahoma	National Historic Preservation Act Section 106	Consultation	Requires federal agency issuing a license to consider cultural impacts and consult with SHPO and/or tribal historic preservation officer.
Muscogee (Creek) Nation	National Historic Preservation Act Section 106	Consultation	Requires federal agency issuing a license to consider cultural impacts and consult with SHPO and/or tribal historic preservation officer.
Seminole Nation of Oklahoma	National Historic Preservation Act Section 106	Consultation	Requires federal agency issuing a license to consider cultural impacts and consult with SHPO and/or tribal historic preservation officer.

9.2 Status of Compliance

Turkey Point has established control measures in place to ensure compliance with the authorizations listed in Table 9.1-1, including monitoring, reporting, and operating within specified limits. Turkey Point environmental compliance coordinators are responsible for monitoring and ensuring that the site complies with its environmental permits and applicable regulations. Monitoring and sampling results associated with environmental programs are submitted to appropriate agencies, as specified in the permits and/or governing regulations.

9.2.1 Site Certification

The Florida PPSA, ss. 403.501-.518, F.S., is the state's centralized process for licensing large power plants. One license, a certification, replaces many of the local and state permits. Local governments and state agencies within whose jurisdiction the power plant is to be built participate in the process. However, additional state and local permits may be required that do not fall under the umbrella of site certification. Certification addresses permitting, land use and zoning, and property interests. A certification grants approval for the location of the power plant and its associated facilities such as a natural gas pipeline supplying the plant's fuel, rail lines for bringing coal to the site, and roadways and electrical transmission lines carrying power to the electrical grid, among others (FDEP 2017g).

Turkey Point Units 3 through 5 are licensed under the Florida PPSA, Chapter 403, Part II, F.S. Those units operate in accordance with the conditions of certification in their license, PA 03-45E. The Florida PPSA process provides a certification that encompasses many licenses and permits needed for affected Florida state, regional, and local agencies. It also includes any regulatory activity applicable under these agencies' regulations for PTN. COC X requires FPL to execute a fifth supplemental agreement with the SFWMD and to revise FPL's monitoring obligations, which resulted in the Turkey Point groundwater, surface water, and ecological monitoring plan, as amended (2009 monitoring plan) incorporated as Exhibit A to the fifth supplemental agreement between the SFWMD and FPL entered on October 16, 2009 (FDEP 2016b). On March 29, 2017, the State of Florida approved an amendment to the final conditions of certification to FPL authorizing the average daily withdrawal of the 28.06 MGD from the upper production zones of the Floridan Aquifer (FDEP 2016a). The final conditions of certification issued are binding and subject to the requirements listed in the Florida PPSA.

9.3 Notices of Violation

In April 2013, the SFWMD sent a letter to FPL indicating that the district had completed its technical analysis of data associated with implementation of the comprehensive pre-uprate monitoring report. The letter also provided notice to FPL to begin consultation with the SFWMD to identify measures to mitigate, abate, or remediate the movement of CCS saline water. Following the issuance of this letter, FPL began active consultation with the FDEP, SFWMD, and MDC DERM. The result of that consultation was an AO issued by the FDEP in December 2014 directing FPL to develop a salinity management plan to lower salinity in the CCS, among other requirements. (FDEP 2014b)

The AO was challenged by several parties, including MDC DERM. On October 2, 2015, MDC DERM issued an NOV to FPL for alleged violations of county water quality standards and criteria in groundwater. At the time the NOV was issued, FPL was working with MDC DERM to address its challenge to the AO. On October 7, 2015, MDC DERM entered into a CA (2015 CA) with FPL, which acknowledged FPL's plans to reduce salinity in the CCS, and required FPL to implement actions to intercept, capture, contain, and retract hypersaline groundwater west and north of the Turkey Point CCS boundary. It also required FPL to conduct additional monitoring and reporting. As a result, MDC DERM dropped its challenge to the AO. (MDC 2015)

The 2015 CA addresses MDC DERM's October 2015 NOV and defines actions that FPL must take. The principal specific objectives of the 2015 CA are for FPL: (1) to demonstrate a statistically valid reduction in salt mass and volumetric extent of the hypersaline water in groundwater west and north of FPL's property without creating adverse environmental impacts and (2) to reduce the rate of and arrest migration of hypersaline groundwater. Frequent meetings and correspondence between FPL and MDC DERM document the continued implementation of the CA. (MDC 2015)

The 2015 CA acknowledged the abatement activities that FPL was undertaking to lower the salinity of the CCS, thus reducing the movement of hypersaline water into the groundwater. The 2015 CA also recognized that factors beyond FPL's control may influence movement of groundwater in the surficial aquifer, and FPL must take into account such factors when developing and implementing remedial actions to minimize the timeframe for achieving compliance with the 2015 CA. FPL is moving forward with the implementation of the activities required by the 2015 CA. The 2015 CA also required FPL to consider alternative water sources to reduce chloride concentration, including, e.g., reclaimed water from Miami-Dade County. (MDC 2015)

The remaining challenges to the AO led to an administrative hearing in which the administrative law judge issued a recommended order to rescind or modify the AO. In response to that recommended order, the FDEP modified and issued the AO as a final AO on April 21, 2016. (FPL 2017c)

On April 25, 2016, the FDEP issued an NOV (the FDEP NOV) regarding the hypersaline groundwater to the west of the CCS and a warning letter identifying concerns related to water quality in deep artificial channels in four specific areas immediately adjacent to the east and south of the CCS. The FDEP NOV directed FPL to enter into consultations to develop a CO to develop corrective actions to reduce the CCS contribution to the hypersaline plume and to reduce the size of the hypersaline plume. On June 20, 2016, a CO (2016 CO) was executed between FPL and the FDEP. The 2016 CO and FPL's compliance with its requirements incorporate the issues and requirements identified in the final AO, as well as the FDEP NOV and the warning letter. As such, the 2016 CO supersedes all requirements of the final AO and rescinds the AO. (FDEP 2016b)

The primary objectives of the 2016 CO are to: (1) cease discharges from the CCS that impair the reasonable and beneficial use of the adjacent G-II groundwaters west of the CCS; (2) prevent releases of groundwater from the CCS to surface waters connected to Biscayne Bay that result in exceedances of surface water quality standards in Biscayne Bay by undertaking restoration projects at Turtle Point and Barge Basin; and (3) provide mitigation to address impacts due to historic operation of the CCS. To meet the first objective, the CO requires FPL to achieve an average annual salinity of 34 PSU by the end of the fourth year of freshening activities. If FPL is unable to meet this target, it must submit a plan to FDEP within 30 days with additional measures that it will implement to meet the target. FPL is moving forward with the implementation of the activities required by the 2016 CO activities including continued implementation of the nutrient management plan and thermal efficiency plan; complete construction of the RWS (Section 3.6.3.2.1) and commence full operation; initiate construction of Barge Basin and Turtle Point Canal restoration projects; and prepare and submit the annual monitoring reports. (FDEP 2016b)

On August 15, 2016, MDC DERM and FPL executed an addendum to the October 2015 CA (2016 CAA). The 2016 CAA requires FPL to take action to address MDC DERM's alleged violations of water quality standards and cleanup target levels relating to the exceedance of ammonia in deep remnant canals adjacent to the Turkey Point CCS. The 2016 CAA required FPL to prepare and submit a SAP to MDC DERM to allow for the identification of source(s) of the ammonia exceedances and the delineation of the vertical and horizontal extent of the subject ammonia exceedances in surface water. Additionally, the SAP was required to adequately address the ammonia exceedances to the surface waters surrounding the facility, including but not limited to, waters tidally connected to Biscayne Bay. (MDC 2016a)

Following MDC DERM approval, and FPL's implementation of the SAP, the 2016 CAA required FPL to prepare and submit a SAR addressing the requirements of the approved SAP, and further submit to MDC DERM a corrective action plan consisting of an environmental restoration plan to correct the exceedances of ammonia; details of proposed process modifications or changes in operational systems to manage and control the source(s) of ammonia to prevent future ammonia exceedances; and physical, structural, or hydraulic modifications to the area of the CCS to eliminate contributions of CCS water to surface water, including a timetable for implementation and completion of the corrective action plan. (MDC 2016a)

There have been no other federal (i.e., agencies other than the NRC), state, or local regulatory NOVs issued to the facility since the last license renewal.

9.4 Remediation Activities

Cooling Canal System

The actions FPL has taken over the last few years have resulted in improved conditions within the CCS. Most notably, FPL has observed improvements in thermal efficiency of the CCS as a direct result of sediment management activities. FPL has also been able to better control water salinity concentrations and algae that can result from significant drought conditions. (FPL 2017c)

Since operations of the underground injection well testing phase of the RWS began on September 28, 2016, as of June 30, 2017, approximately 3.7 BG of hypersaline groundwater from beneath the CCS have been extracted and disposed of in the naturally saline Boulder Zone formation located 3,200 feet below the surface. This amounts to approximately 890,000 tons of salts removed from the Biscayne Aquifer beneath the CCS. Construction of the ten RWS extraction wells began in June 2017 and the wells are expected to begin operations in early 2018. Groundwater models of the RWS indicate the westward migration of the hypersaline plume will be stopped in three years of operation, with retraction of the hypersaline plume north and west of the CCS beginning in 5 years. Retraction of the plume back to the FPL site boundary is projected in 10 years. (FPL 2017c)

As noted above, the extracted groundwater is disposed of in a deep injection well in the Boulder Zone under FDEP Permit No. 293962-002-UC. The FDEP has permitted FPL and others to discharge treated sewage and other wastes through injection wells into the Boulder Zone. The Boulder Zone is located in the Lower Floridan Aquifer and is overlaid by a confining layer that prevents upward migration of the water (see Section 3.6.2 for detailed description of the aquifers underlying PTN). The competency of the middle confining layer at the Turkey Point site was recently evaluated and confirmed by the NRC staff as part of the PTN Units 6 and 7 licensing proceeding (ASLB 2017; NRC 2016a, Section 5.2.13; NRC 2016d, Section 11.2.4).

FPL has determined that Upper Floridan Aquifer water wells are the best choice of water supply for meeting its CCS freshening objective. Operation of the 14 MGD Upper Floridan Aquifer freshening well system began on November 28, 2016. The brackish water from the Floridan wells (2.5 PSU compared to bay salinity at 34 PSU) is being used to help reduce the CCS salinity to an average annual level of 34 PSU, essentially equivalent to the salinity of the bay. The addition of this water was instrumental in minimizing the increase in salinity that ordinarily occurs during the dry season. Continued operation of the freshening wells during the wet season will further reduce CCS salinities, achieving progress towards the overall goal of 34 PSU. (FPL 2017c)

Deep Canal Ammonia

The SAP was submitted to the MDC DERM on September 14, 2016 and approved for implementation on December 21, 2016. The SAR was submitted on March 17, 2017 and concluded that the CCS is not the source of the measured elevated ammonia samples collected at some of the adjacent remnant canals connected to Biscayne Bay. (FPL 2017d)

The data collected during the SAR investigation indicate the presence of elevated ammonia values in excess of MDC DERM surface water standards is not the result of point or non-point source contamination attributable to the Turkey Point site. Rather, the report concluded the occurrence of elevated ammonia is the result of the conversion of organic nitrogen sourced from organic wetland soils, decomposition of wetland and aquatic plant material, atmospheric nitrogen fixation, and natural microbial processes in anoxic, stagnant surface and groundwater environments similar to numerous other such occurrences documented along the coastal Biscayne Bay region. Therefore, FPL concludes that additional assessment work associated with the 2016 CAA is not warranted based on the SAP results. There is no evidence of any sources of ammonia being caused by FPL that warrant a corrective action plan by FPL. (FPL 2017d)

9.5 Federal, State, and Local Regulatory Standards: Discussion of Compliance

This section contains information regarding environmental programs identified in the 2013 GEIS that may or may not be applicable to the site, and current status of compliance with each program.

9.5.1 Atomic Energy Act

9.5.1.1 Radioactive Waste

As discussed in Section 2.2.6, PTN utilizes liquid, gaseous, and solid radioactive waste-management systems to collect and treat radioactive materials produced from the plants' generation. As a generator of both LLRW and spent fuel, PTN is subject to and complies with provisions and requirements of the Low-Level Radioactive Waste Policy Amendment Act of 1985 and the Nuclear Waste Policy Act of 1982, as subsequently amended.

PTN also complies with permits issued by (1) the Central Interstate Low-Level Radioactive Waste Commission for exporting radioactive waste outside the region; (2) the Mississippi Emergency Management Agency for transportation of radioactive material into, within, or through the state of Mississippi; and (3) the Tennessee Department of Environment and Conservation for shipping radioactive material to a licensed disposal/processing facility within the state of Tennessee.

9.5.2 Clean Air Act

9.5.2.1 Air Permit

PTN has a permit to operate backup diesel generators, diesel generator engines, and one diesel pump (FDEP 2014a).

Operation of these air emission sources is maintained within the emissions, opacity, fuel sulfur content, and fuel usage (as applicable) limits established in the station air permit issued by the FDEP. As required by the air permit, reports are submitted annually and semiannually to the FDEP. Due to its co-location with the Turkey Point Fossil Plant, PTN is considered a Title V major emission source. PTN is in compliance with this permit.

9.5.2.2 Chemical Accident Prevention Provisions [40 CFR Part 68]

PTN is not required to have a risk management plan under 40 CFR Part 68 because the amount of regulated chemicals present on site does not exceed the threshold quantities specified in 40 CFR 68.130 (FDEP 2014a).

9.5.2.3 Stratospheric Ozone [40 CFR 82]

Under Title VI of the CAA, the EPA is responsible for several programs that protect the stratospheric ozone layer. Regulations promulgated by the EPA to protect the ozone layer are contained in 40 CFR Part 82. Refrigeration appliances and motor vehicle air conditioners are regulated under Sections 608 and 609 of the CAA, respectively. A number of service practices, refrigerant reclamation, technician certification, and other requirements are covered by these programs. PTN is in compliance with Section 608 of the CAA as amended in 1990 and the implementing regulations codified in these regulations. The program to manage stationary refrigeration appliances at PTN is described in the FPL administrative procedure "Title VI: Stratospheric Ozone Protection" (PTN 2017c).

Because motor vehicle air conditioners are not serviced on site, Section 609 of the CAA is not applicable.

9.5.2.4 Stratospheric Ozone [Section 24-18(A)17 of the Miami-Dade County Code]

Section 24-18(A)17 of the Miami-Dade County Code requires that a stratospheric ozone protection permit be obtained to ensure that individuals meet and maintain the required training and certification and that they utilize the required recovery and recycling equipment and approved practices to prevent venting of ozone-depleting compounds (ODCs) to the environment. A permit is required to:

- Purchase, sell, offer to sale, let, or allow the distribution of regulated ODCs as defined in 24-5 of Chapter 24, the Environmental Code of Miami-Dade County. Regulated ODCs include, but are not limited to, Freon (R-12 and R-22), halon, and various other compounds defined by the EPA as having ozone-depleting potential.

- Perform installation, evacuation, recharge, repair, salvage, and maintenance services on any appliance or system containing regulated ODCs. Examples of these appliances or systems include, but are not limited to, mobile (automotive and freight) and stationary (wall and central) air-conditioning units, refrigerators, freezers, and fire extinguishing systems.

- Handle, recover, or recycle regulated ODCs from any appliance or system.

PTN operates under MDC DERM stratospheric ozone protection permit number APCF-001747 (Table 9.1-1). PTN is in compliance under Section 24-18(A)17 of the Miami-Dade County Code and maintains fleet procedures to ensure compliance (PTN 2017c).

9.5.3 Clean Water Act

9.5.3.1 Section 10/404 Permitting

PTN is currently seeking authorization through the FDEP and USACE for fill activities in the Barge Basin and Turtle Point. The canal was previously dredged to approximately -20 to -28 feet NAVD88 during the original construction of the plant to allow once-through cooling water from Units 1 and 2 to be discharged to the bay. The construction of the CCS replaced the need for the original cooling water discharge. Cooling water is no longer discharged, and the remnant canal has been plugged. The remnant canal and the adjacent area of scour are proposed to be backfilled to improve water quality in Biscayne Bay (FPL 2016d). PTN will comply with all regulatory requirements imposed by the FDEP and USACE as they relate to performing activities in federal jurisdictional waters.

9.5.3.2 Water Quality (401) Certification

Federal CWA Section 401 requires that applicants for a federal license to conduct an activity that might result in a discharge into navigable waters provide the licensing agency with a certification from the state that the discharge will comply with applicable CWA requirements (33 USC 1341). FPL is applying to the NRC for a license (i.e., license renewal) to continue PTN operations. PTN discharges to the CCS, which is not considered waters of the U.S.

FPL received confirmation of 401 certification in a letter from the FDEP to the USACE dated March 9, 2012 (FDEP 2012). The operating agreement between the FDEP and participating agencies identifies the final order issued as part of the PPSA as the 401 certification for the authorized power plant. Therefore, PTN has fulfilled the regulatory requirement to provide certification by the state.

9.5.3.3 NPDES Permit

FPL operates the CCS (IWW facility) under NPDES/IWW permit number FL0001562. This permit is issued pursuant to the federal NPDES program and Florida IWW permitting program. The permit authorizes wastewater discharges from the generating units through two internal outfalls into the CCS. The permit does not authorize direct discharges to surface waters of the state. The permit authorizes discharges from the CCS into Class G-III groundwater, which is part of the surficial aquifer system. Condition IV.1 of the permit provides that discharges to groundwater shall not cause a violation of the minimum criteria for groundwater specified in Rules 62-520.400 FAC, 62-520.430 FAC, and 62-520.400 FAC provide that discharges to groundwater shall not impair the reasonable and beneficial use of adjacent waters, either ground or surface (FDEP 2005).

9.5.3.4 Stormwater Permit

Plant stormwater is recycled to the CCS (IWW facility), which is an FDEP-permitted wastewater treatment facility. PTN has no intake or direct discharge to surface waters and therefore is designated as a zero-discharge facility under the NPDES permit. The NPDES permit requires monitoring of water quality at the internal outfalls that handle facility wastewater. The state IWW/NPDES permit is incorporated into the conditions of certification (State of Florida 2016)

9.5.3.5 Sanitary Wastewaters

As previously discussed in Section 2.2.7, PTN is equipped with its own sewage treatment plant. Sanitary waste from showers, water closets, toilets, etc. is routed to county-approved onsite septic systems for the fossil and land management facilities. The nuclear units' domestic wastewater is routed to an onsite, county and state approved, contact stabilization sewage treatment plant. Sanitary wastewater from PTN is regulated by PTN's MDC DERM permit number DWO-00010-99 (DERM 2017).

FPL complies with monthly reporting requirements to the FDEP to ensure compliance with permit conditions.

9.5.3.6 Spill Prevention, Control, and Countermeasures

The EPA's Oil Pollution Prevention Rule became effective January 10, 1974, and was published under the authority of Section 311(j)(1)(C) of the Federal Water Pollution Control Act. The regulation has been published in 40 CFR Part 112, and facilities subject to the rule must prepare and implement an SPCC plan to prevent any discharge of oil into or upon navigable waters of the United States or adjoining shorelines. PTN is subject to this rule and has a written SPCC plan that identifies and describes the procedures, materials, equipment, and facilities that are utilized at the station to minimize the frequency and severity of oil spills to meet the requirements of this rule.

9.5.3.7 Reportable Spills [40 CFR Part 110]

PTN is subject to the reporting provisions of 40 CFR Part 110 as it relates to the discharge of oil in such quantities as may be harmful pursuant to Section 311(b)(4) of the Federal Water Pollution Control Act. Any discharges of oil in such quantities that may be harmful to the public health or welfare or the environment must be reported to the EPA's national response center. Based on a review of records over the previous 5 years (2012–2016), there have been no releases at PTN that have triggered this notification requirement.

9.5.3.8 Reportable Spills [FAC 62-780.110]

PTN is also subject to the reporting provisions of FAC 62-780.110, and under the conditions of certification Attachment 4. This reporting provision requires that any release of oil having the potential to significantly pollute surface or groundwaters and which are not confined to a building or similar structure reported to the FDEP, the coordinator of emergency services of the locality that could reasonably be expected to be impacted, and appropriate federal authorities. Based on a review of records over the previous 5 years (2011–2016), there have been no releases at PTN that have triggered this notification requirement .

9.5.3.9 Facility Response Plan

PTN is not subject to the facility response plan risk requirements described in 40 CFR 112.20 because the facility does not transfer oil over water to or from vessels and does not store oil in quantities greater than 1 million gallons.

9.5.4 Safe Drinking Water Act

9.5.4.1 Safe Drinking Water Act

As discussed in Section 2.2.3, potable water for PTN is obtained from the Miami-Dade Rex system, which is part of the county's public water supply system. This water is used for plant processes, potable water, and for the plant fire protection program.

A new replacement water treatment plant, which supplies pure water for steam-related use, was completed in 2017. The new plant has the ability to treat either potable water or Upper Floridan Aquifer well water (as does the Unit 5 treatment plant). Injection wells on the Turkey Point site are permitted through the FDEP and do not endanger drinking water sources. Compliance with these permits (Table 9.1-1) ensures compliance under the Safe Drinking Water Act.

9.5.5 Endangered Species Act

Potential impacts on federally and state-listed species were considered in FPL's review and analysis in Section 4.6.6, and it was concluded that none would likely be adversely affected as a result of SLR.

Section 7 of the ESA requires federal agencies to ensure that their actions are not likely to jeopardize the continued existence of species that are listed, or proposed for listing, as endangered or threatened. Depending on the action involved, the ESA requires consultation with the USFWS, and with the NMFS if marine or anadromous species could be affected. Although FPL has invited comment from the USFWS and NMFS (Attachment B), a more structured consultation process with these agencies may be initiated by the NRC per Section 7 of the ESA.

9.5.6 Migratory Bird Treaty Act

The MBTA makes it unlawful to pursue, hunt, take, capture, kill, or sell birds listed and grants protection to any bird parts including feathers, eggs, and nests. FPL maintains state and federal avian permits, included in Table 9.1-1.

9.5.7 Bald and Golden Eagle Protection Act

The BGPA prohibits the take, transport, sale, barter, trade, import and export, and possession of eagles, making it illegal for anyone to collect eagles and eagle parts, nests, or eggs without a USFWS permit. Bald eagles are known to use the Turkey Point site; therefore, consultation with the USFWS is conducted prior to new activities and maintenance activities to ensure compliance with the BGPA. There are currently no BGPA permitting requirements associated with PTN operations.

9.5.8 Magnuson-Stevens Fishery Conservation and Management Act

As discussed in Section 3.7.8.3, according to the 2009 EFH Final Amendment, potential EFH exists within the proposed project area for the following species:

- Adult and juvenile gray snapper (*Lutjanus griseus*)
- All life stages of dog snapper (*L. jocu*)
- Juvenile mutton snapper (*L. analis*)
- All life stages of bluestriped grunt (*Haemulon sciurus*)
- Adult white grunt (*H. plumieri*)

- Juvenile and adult spiny lobster (*Panulirus argus*)
- All life stages of pink shrimp (*Farfantepenaeus duorarum*)

FPL has invited comment from the NMFS. Attachment B includes a copy of FPL correspondence with the DNR regarding potential effects that PTN SLR might have on EFH and HAPCs.

9.5.9 Marine Mammal Protection Act

The Marine Mammal Protection Act prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the United States. There are currently no Marine Mammal Protection Act permitting requirements associated with PTN operations.

9.5.10 Coastal Zone Management Act

The federal Coastal Zone Management Act [16 USC 1451 et seq.] imposes requirements on applicants for a federal license to conduct an activity that could affect a state's coastal zone. The act requires the applicant to certify to the licensing agency that the proposed activity would be consistent with the state's federally approved coastal zone management program [16 USC 1456(c)(3)(A)]. NOAA has promulgated implementing regulations indicating that the requirement is applicable to renewal of federal licenses for activities not previously reviewed by the state [15 CFR 930.51(b)(1)]. The regulation requires the license applicant to provide its certification to the federal licensing agency and a copy to the applicable state agency [15 CFR 930.57(a)].

The NRC's Office of Nuclear Reactor Regulation has issued guidance to its staff regarding compliance with the act. This guidance acknowledges that Florida has an approved coastal zone management program (NRC 2013c). The entire state of Florida is designated as a coastal zone; therefore, Turkey Point is located within the Florida coastal zone.

FPL received confirmation of coastal zone certification in a letter dated March 9, 2012, from the FDEP to the USACE (FDEP 2012). The operating agreement between the FDEP and participating agencies identifies the final order issued as part of the PPSA as the CZMA consistency for the authorized power plant. Therefore, PTN has fulfilled the regulatory requirement to certify to the licensing agency that the proposed activity would be consistent with the state's federally approved coastal zone management program.

9.5.11 National Historic Preservation Act

Potential impacts on historic properties were considered in FPL review and analysis in Section 4.7.4.2, and it was concluded that no eligible historic properties are present on the Turkey Point site. As previously discussed in Section 3.8.6, administrative controls are in place for management of cultural resources ahead of any future ground-disturbing activities at the plant. These controls ensure that existing or potentially existing cultural resources are adequately protected, and assist PTN in meeting state and federal expectations.

Section 106 of the NHPA (16 USC 470 et seq.) requires federal agencies having the authority to license any undertaking, prior to issuing the license, to take into account the effect of the undertaking on historic properties and to afford the Advisory Council on Historic Preservation an opportunity to comment on the undertaking. Council regulations provide for establishing an agreement with any SHPO to substitute state review for council review (35 CFR 800.7). Although not required of an applicant by federal law or NRC regulation, FPL has invited comment from the Florida SHPO. Attachment C includes a copy of FPL correspondence with the Florida SHPO regarding potential effects that PTN SLR might have on historic or cultural resources. In accordance with Section 101(d)(2) of the NHPA (P.L. 102-575), FPL has chosen to initiate consultation with SHPO-identified tribal historic preservation officers (THPOs), designated representatives of tribes with no THPO, and with Indian tribes that may attach religious and cultural significance to historic properties within Florida.

9.5.12 Resource Conservation and Recovery Act

9.5.12.1 Nonradioactive Wastes

As a generator of hazardous and nonhazardous wastes, PTN is subject to and complies with RCRA and specific FDEP regulations contained in the site certification conditions of certification. PTN is classified as a small quantity generator of hazardous wastes (EPA 2017d). As a generator of hazardous wastes, PTN also maintains a hazardous waste generator identification number (Table 9.1-1). PTN has not received any violations for hazardous waste management in the past 5 years based on a review of its compliance history (EPA 2017d).

For most hazardous waste records, the regulations require that records be retained for at least 3 years from the date the hazardous waste, for which the record pertains, is last shipped offsite. It is an FPL fleet procedure to maintain most records for 3 years in accordance with the FPL non-radiological environmental protection program administrative guidance.

9.5.12.2 Reportable Spills [40 CFR Part 262]

PTN is subject to the reporting provisions of 40 CFR 262.34(d)(5)(iv)(C) as it relates to a fire, explosion, or other release of hazardous waste which could threaten human health outside the facility boundary or when the facility has knowledge that a spill has reached surface water. Any such events must be reported to the EPA's national response center.

Based on a review of records over the previous 5 years (2012–2016), there have been no releases at PTN that have triggered this notification requirement (EPA 2017e).

9.5.12.3 Mixed Wastes

Radioactive materials are regulated by the NRC under the AEA of 1954, and hazardous wastes are regulated by the EPA under the RCRA of 1976. Management of radioactive waste at PTN is discussed in Section 2.2.6. FPL has developed guidance documents for managing its hazardous waste streams, including mixed wastes. In addition, FPL inspects its waste management areas for compliance. FPL's management of its waste streams is in compliance with applicable regulatory standards and has not resulted in any NOVs for the 2012–2016 timeframe (EPA 2017e). FPL would continue to store and dispose of hazardous and nonhazardous waste in accordance with EPA and state regulations and dispose of the wastes in appropriately permitted treatment and disposal facilities during the SLR term. As indicated in the 2013 GEIS, PTN will continue existing systems and procedures to ensure proper storage and disposal.

9.5.12.4 Underground Storage Tanks [FAC 62-761]

FPL no longer utilizes underground storage tanks at Turkey Point. The six tanks previously utilized on the site have been removed (FDEP 2015).

9.5.12.5 Reportable Spills [§Site Certification]

FPL no longer utilizes underground storage tanks at Turkey Point; therefore, PTN is not subject to reporting requirements for the release of regulated substances from underground storage tanks.

9.5.13 Pollution Prevention Act

In accordance with RCRA Section 3002(b) and 40 CFR 262.27, a small or large quantity generator must certify that a waste minimization program is in place to reduce the volume and toxicity of the waste generated to the degree determined to be economically practical. As previously discussed in Section 4.11.5.4, PTN is meeting this requirement as procedural measures are in place to minimize hazardous waste generated to the maximum extent practical.

9.5.14 Federal Insecticide, Fungicide, and Rodenticide Act

Commercially approved herbicides may be used to maintain linear facilities connecting the collector yard to the switch yard. Maintenance must be performed in accordance with the SCA and any state and federal regulations concerning the use of herbicides. FPL must notify the FDEP Southeast District of the Department of Siting Coordination Office of the type of herbicides to be used at least 60 days prior to their first use (FDEP 2016a).

9.5.15 Toxic Substances Control Act

The Toxic Substances Control Act of 1976 regulates PCBs [40 CFR Part 761] and asbestos [40 CFR Part 763], both of which may be present at PTN. FPL procedure 0-ENV-601 provides guidance for asbestos removal to ensure compliance with state and federal regulations. PTN is in compliance with the PCB and asbestos regulations applicable to the facility.

9.5.16 Hazardous Materials Transportation Act

Because PTN ships offsite the hazardous materials regulated by the USDOT, the facility is subject to and complies with the applicable requirements of the Hazardous Materials Transportation Act described in 49 CFR, including the requirement to possess a current hazardous materials certificate of registration (Table 9.1-1).

9.5.17 Emergency Planning and Community Right-to-Know Act

9.5.17.1 Section 312 Reporting [40 CFR Part 370]

PTN is subject to and complies with Section 312 of the Emergency Planning and Community Right-to-Know Act, which requires the submission of an emergency and hazardous chemical inventory report (Tier II) to the local emergency planning commission, the state emergency response commission, and the local fire department. This report, which typically includes, but is not limited to, chemicals such as ammonium hydroxide, boric acid, CO_2, diesel fuel, electrohydraulic fluid, ethylene glycol, gasoline, hydrazine, hydrogen, lube oils, Nalco products, nitrogen, sodium hydroxide, and sulfuric acid, is submitted to these agencies annually.

9.5.17.2 Section 313 Reporting [40 CFR Part 372]

Because PTN is located on the same property as Turkey Point Units 1, 2, and 5, and the facilities are owned by the same entity, the facilities are designated as one "complex." By default, this subjects PTN to the Section 313 Toxic Release Inventory reporting requirements. Although reporting under this requirement may not be applicable in certain calendar years given, PTN is in compliance with the Section 313 Toxic Release Inventory reporting requirements.

9.5.18 Comprehensive Environmental Response, Compensation, and Liability Act

PTN is subject to the hazardous substance release and reporting provisions of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as subsequently amended. Any release of reportable quantities of listed hazardous substances to the environment requires a notification to the EPA's national response center, the FDEP, and subsequent written follow-up within 15 days of the release. Based on a review of records over the previous 5 years (2012–2016), no releases at PTN have triggered this notification requirement. PTN has not received any NOVs for hazardous waste management in the past 5 years based on a review of its compliance history (EPA 2017f).

9.5.19 Farmland Protection Policy Act

The FPPA only applies to federal programs. The term "federal program" under this act does not include federal permitting or licensing for activities on private or non-federal lands. Therefore, because license renewal is considered a federal licensing activity and PTN is located on non-federal lands, the FPPA is not applicable.

9.5.20 Federal Aviation Act

Coordination with the Federal Aviation Administration (FAA) is required when it becomes necessary to ensure that the highest structures associated with the project do not impair the safety of aviation. Submission of a letter of notification (with accompanying maps and project description) to the FAA would result in a written response from the FAA certifying that no hazard exists or recommending project changes and/or the installation of warning devices such as lighting. PTN was originally authorized under FAA permit numbers 2009-ASO-4093-OE and

2009-ASO-4094-OE. The Turkey Point property is currently authorized under FAA permit numbers 2015-ASO-11359-OE (Unit 6) and 2015-ASO-11360-OE (Unit 7) (Table 9.1-1). No license renewal-related construction activities have been identified; therefore, no new notifications to the FAA are required.

9.5.21 Occupational Safety and Health Act

OSHA governs the occupational safety and health of the construction workers and operations staff. PTN and its contractors comply with OSHA's substantive requirements, as these are incorporated in the sites occupational health and safety practices.

9.5.22 State Water Use Program

The SCA for PTN authorized the average daily withdrawal of 28.06 mgd from the upper production zones of the Floridan Aquifer. Pursuant to section 373.236(4), F.S., every 10 years from the date of certification issuance, PTN must submit a water use compliance report for review and approval by SFWMD (FDEP 2016a). PTN is in compliance with this reporting requirement.

9.5.23 Miami-Dade County Zoning Requirements

PTN is located in unincorporated Miami-Dade County, Florida. Miami-Dade County has adopted a CDMP to meet the requirements of the Local Government Comprehensive Planning and Land Development Regulation Act, Chapter 163, Part II, F.S. The CDMP was last revised in October 2006 (FPL 2008).

PTN has a future land use category of "institutions, utilities, and communications," according to the Miami-Dade County CDMP map. The CDMP map illustrates the locations of major institutional uses, communication facilities, and utilities of metropolitan significance. The Miami-Dade County CDMP land use element allows a full range of institutions, communications, and utilities in the "institutions, utilities, and communications" future land use category. PTN, as well as Turkey Point Units 1, 2, and 5, are an allowed use under this land use designation (FPL 2008).

The Miami-Dade County Land Development Code (Code) has been adopted to implement the policies and objectives of the Miami-Dade CDMP and to regulate land development within the unincorporated portions of Miami-Dade County. The Code incorporates a zoning map that depicts the zoning categories of lands lying within unincorporated Miami-Dade County. PTN is zoned as "industrial unlimited manufacturing district" (IU-3). The IU-3 zoning district allows "atomic reactors" (i.e., nuclear reactors) as a permitted use in the Code. The SLR project is an allowed use in the IU-3 district and does not represent a change or adjustment to the existing use status of PTN. The Miami-Dade County Department of Planning and Zoning has concurred with that conclusion (FPL 2008). PTN is in compliance with all zoning requirements.

9.6 Environmental Reviews

FPL has procedural controls in place to ensure that environmentally sensitive areas at Turkey Point, if present, are adequately protected during site operations and project planning. These controls, which encompass nonradiological environmental resource areas such as land use, air quality, surface water and groundwater, terrestrial and aquatic ecology, historic and cultural resources, and waste management and pollution prevention consist of the following:

- Appropriate local, state, and/or federal permits are obtained or modified as necessary.
- BMPs are implemented to protect wetlands, natural heritage areas, and sensitive ecosystems.
- Appropriate agencies are consulted on matters involving federally and state-listed threatened, endangered, and protected species, and that BMPs are implemented to minimize impacts to these species.
- Appropriate agencies are consulted on matters involving cultural resources and to ensure BMPs are implemented to minimize impact to this resource.

In summary, FPL's administrative controls ensure that appropriate local, state, and/or federal permits are obtained or modified as necessary, that cultural resources and threatened and endangered species are protected if present, and that other regulatory issues are adequately addressed as necessary.

9.7 Alternatives

The discussion of alternatives in the ER shall include a discussion of whether alternatives will comply with such applicable environmental quality standard and requirements [10 CFR 51.45 (d)].

The natural gas combined cycle plant, new nuclear, and combination of natural gas combined cycle, and solar PV combination alternative discussed in Section 7.2.1 would be constructed and operated to comply with all applicable environmental quality standards and requirements.

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evidence of a chilled environment at the Byron Station.

III. Conclusion

The NRC staff conducted inspections at the Byron Station and Braidwood Station that assessed the licensee's compliance with the regulations under 10 CFR part 50, Appendix B, Criterion III, ''Design Control,'' and Criterion XVI, ''Corrective Action,'' related to the adequacy of the AOR for the structural design of the MSIV house and the main steam tunnel, and took enforcement action as outlined in the inspection reports identified above. The NRC staff requested that the licensee evaluate the SCWE concerns expressed in the petition, and conducted an inspection that assessed the licensee's SCWE at Byron Station. Based on the licensee's voluntary response and the results of the inspection, the NRC staff did not identify challenges to the licensee's SCWE or evidence of a chilled environment at the Byron Station and, therefore, determined that issuance of a chilling effect letter was not warranted. Because these actions address the underlying concerns raised in requests 1, 2, 4, and 5 of the petition, the petition is granted in part.

As provided in 10 CFR 2.206(c), a copy of this director's decision will be filed with the Secretary of the Commission for review. As provided by this regulation, the decision will constitute the final action of the Commission 25 days after the date of the decision unless the Commission, on its own motion, institutes a review of the decision within that time.

Dated at Rockville, Maryland, this 24th day of April, 2018.

For the Nuclear Regulatory Commission.

Brian E. Holian,

Acting Director, Office of Nuclear Reactor Regulation.

[FR Doc. 2018–09210 Filed 5–1–18; 8:45 am]

BILLING CODE 7590–01–P

NUCLEAR REGULATORY COMMISSION

[Docket Nos. 50–250 and 50–251; NRC–2018–0074]

Florida Power & Light Company; Turkey Point Nuclear Generating, Unit Nos. 3 and 4

AGENCY: Nuclear Regulatory Commission.

ACTION: License renewal application; opportunity to request a hearing and to petition for leave to intervene.

SUMMARY: The U.S. Nuclear Regulatory Commission (NRC) is considering an application for the subsequent license renewal of Renewed Facility Operating License Nos. DPR–31 and DPR–41, which authorize Florida Power & Light Company (FPL or the applicant) to operate Turkey Point Nuclear Generating Unit Nos. 3 and 4 (Turkey Point). The renewed licenses would authorize the applicant to operate Turkey Point for an additional 20 years beyond the period specified in each of the current renewed licenses. The current renewed operating licenses for Turkey Point expire as follows: Unit No. 3 on July 19, 2032, and Unit No. 4 on April 10, 2033.

DATES: A request for a hearing or petition for leave to intervene must be filed July 2, 2018.

ADDRESSES: Please refer to Docket ID NRC–2018–0074 when contacting the NRC about the availability of information regarding this document. You may obtain publicly-available information related to this document using any of the following methods:

- *Federal Rulemaking website:* Go to *http://www.regulations.gov* and search for Docket ID NRC–2018–0074. Address questions about NRC dockets to Jennifer Borges; telephone: 301–287–9127; email: *Jennifer.Borges@nrc.gov.* For technical questions, contact the individual listed in the **FOR FURTHER INFORMATION CONTACT** section of this document.
- *NRC's Agencywide Documents Access and Management System (ADAMS):* You may obtain publicly-available documents online in the ADAMS Public Documents collection at *http://www.nrc.gov/reading-rm/adams.html.* To begin the search, select ''ADAMS Public Documents'' and then select ''Begin Web-based ADAMS Search.'' For problems with ADAMS, please contact the NRC's Public Document Room (PDR) reference staff at 1–800–397–4209, 301–415–4737, or by email to *pdr.resource@nrc.gov.* The ADAMS accession number for each document referenced (if it is available in ADAMS) is provided the first time that it is mentioned in this document.
- *NRC's PDR:* You may examine and purchase copies of public documents at the NRC's PDR, Room O1–F21, One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852.

FOR FURTHER INFORMATION CONTACT: Lois M. James, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001; telephone: 301–415–3306, email: *Lois.James@nrc.gov.*

SUPPLEMENTARY INFORMATION:

I. Introduction

By letters dated January 30, 2018 (ADAMS Package Accession No. ML18037A812); February 9, 2018 (ADAMS Accession No. ML18044A653); February 16, 2018 (ADAMS Package Accession No. ML18053A123); March 1, 2018 (ADAMS Package Accession No. ML18072A224), and April 10, 2018 (ADAMS Package Accession No. ML18102A521 and Accession No. ML18113A132), the NRC received an application from FPL, filed pursuant to Section 103 of the Atomic Energy Act of 1954, as amended (the Act), and part 54 of title 10 of the *Code of Federal Regulations* (10 CFR), to renew the operating licenses for Turkey Point at 2,644 megawatt thermal each. The Turkey Point units are pressurized-water reactors designed by Westinghouse Electric Company and are located in Homestead, Miami-Dade County, Florida. A notice of receipt of the subsequent license renewal application (SLRA) was published in the **Federal Register** (FR) on April 18, 2018 (83 FR 17196).

The NRC staff has determined that FPL has submitted sufficient information in accordance with 10 CFR 54.19, 54.21, 54.22, 54.23, 51.45, and 51.53(c), to enable the staff to undertake a review of the application, and that the application is, therefore, acceptable for docketing. The current Docket Nos. 50–250 and 50–251 for Renewed Facility Operating License Nos. DPR–31 and DPR–41, respectively, will be retained. The determination to accept the SLRA for docketing does not constitute a determination that a subsequent renewed license should be issued, and does not preclude the NRC staff from requesting additional information as the review proceeds.

Before issuance of the requested subsequent renewed licenses, the NRC will have made the findings required by the Act, and the Commission's rules and regulations. In accordance with 10 CFR 54.29, the NRC may issue a subsequent renewed license on the basis of its review if it finds that actions have been identified and have been or will be taken with respect to: (1) Managing the effects of aging during the period of extended operation on the functionality of structures and components that have been identified as requiring aging management review; and (2) time-limited aging analyses that have been identified as requiring review, such that there is reasonable assurance that the activities authorized by the renewed licenses will continue to be conducted in accordance with the current licensing basis and that any changes made to the plant's current licensing basis will comply with the Act and the Commission's regulations.

Additionally, in accordance with 10 CFR 51.95(c), the NRC will prepare an environmental impact statement as a supplement to the Commission's NUREG–1437, ''Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants,'' dated June 2013. In considering the SLRA, the Commission must find that the applicable requirements of subpart A of 10 CFR part 51 have been satisfied, and that any matters raised under 10 CFR 2.335 have been addressed. Pursuant to 10 CFR 51.26, and as part of the environmental scoping process, the staff intends to hold public scoping meetings. Detailed information regarding the environmental scoping meetings will be the subject of a separate **Federal Register** notice.

II. Opportunity To Request a Hearing and Petition for Leave To Intervene

Within 60 days after the date of publication of this notice, any persons (petitioner) whose interest may be affected by this action may file a request for a hearing and petition for leave to intervene (petition) with respect to the action. Petitions shall be filed in accordance with the Commission's ''Agency Rules of Practice and Procedure'' in 10 CFR part 2. Interested persons should consult a current copy of 10 CFR 2.309. The NRC's regulations are accessible electronically from the NRC Library on the NRC's website at *http://www.nrc.gov/reading-rm/doc-collections/cfr/.* Alternatively, a copy of the regulations is available at the NRC's Public Document Room, located at One White Flint North, Room O1–F21, 11555 Rockville Pike (First Floor), Rockville, Maryland 20852. If a petition is filed, the Commission or a presiding officer will rule on the petition and, if appropriate, a notice of hearing will be issued.

As required by 10 CFR 2.309, a petition should specifically explain the reasons why intervention should be permitted with particular reference to the following general requirements for standing: (1) The name, address, and telephone number of the petitioner; (2) the nature of the petitioner's right under the Act to be made a party to the proceeding; (3) the nature and extent of the petitioner's property, financial, or other interest in the proceeding; and (4) the possible effect of any decision or order which may be entered in the proceeding on the petitioner's interest.

In accordance with 10 CFR 2.309(f), the petition must also set forth the specific contentions which the petitioner seeks to have litigated in the proceeding. Each contention must consist of a specific statement of the issue of law or fact to be raised or controverted. In addition, the petitioner must provide a brief explanation of the bases for the contention and a concise statement of the alleged facts or expert opinion which support the contention and on which the petitioner intends to rely in proving the contention at the hearing. The petitioner must also provide references to the specific sources and documents on which the petitioner intends to rely to support its position on the issue. The petition must include sufficient information to show that a genuine dispute exists with the applicant or licensee on a material issue of law or fact. Contentions must be limited to matters within the scope of the proceeding. The contention must be one which, if proven, would entitle the petitioner to relief. A petitioner who fails to satisfy the requirements at 10 CFR 2.309(f) with respect to at least one contention will not be permitted to participate as a party.

Those permitted to intervene become parties to the proceeding, subject to any limitations in the order granting leave to intervene. Parties have the opportunity to participate fully in the conduct of the hearing with respect to resolution of that party's admitted contentions, including the opportunity to present evidence, consistent with the NRC's regulations, policies, and procedures.

Petitions must be filed no later than 60 days from the date of publication of this notice. Petitions and motions for leave to file new or amended contentions that are filed after the deadline will not be entertained absent a determination by the presiding officer that the filing demonstrates good cause by satisfying the three factors in 10 CFR 2.309(c)(1)(i) through (iii). The petition must be filed in accordance with the filing instructions in the ''Electronic Submissions (E-Filing)'' section of this document.

A State, local governmental body, Federally-recognized Indian Tribe, or agency thereof, may submit a petition to the Commission to participate as a party under 10 CFR 2.309(h)(1). The petition should state the nature and extent of the petitioner's interest in the proceeding. The petition should be submitted to the Commission no later than 60 days from the date of publication of this notice. The petition must be filed in accordance with the filing instructions in the ''Electronic Submission (E-Filing)'' section of this document, and should meet the requirements for petitions set forth in this section, except that under 10 CFR 2.309(h)(2) a State, local governmental body, or Federally-recognized Indian Tribe, or agency thereof does not need to address the standing requirements in 10 CFR 2.309(d) if the facility is located within its boundaries. Alternatively, a State, local governmental body, Federally-recognized Indian Tribe, or agency thereof may participate as a non-party under 10 CFR 2.315(c).

If a hearing is granted, any person who is not a party to the proceeding and is not affiliated with or represented by a party may, in the discretion of the presiding officer, be permitted to make a limited appearance pursuant to the provisions of 10 CFR 2.315(a). A person making a limited appearance may make an oral or written statement of his or her position on the issues but may not otherwise participate in the proceeding. A limited appearance may be made at any session of the hearing or at any prehearing conference, subject to the limits and conditions as may be imposed by the presiding officer. Details regarding the opportunity to make a limited appearance will be provided by the presiding officer if such sessions are scheduled.

III. Electronic Submissions (E-Filing)

All documents filed in NRC adjudicatory proceedings, including a request for hearing and petition for leave to intervene (petition), any motion or other document filed in the proceeding prior to the submission of a request for hearing or petition to intervene, and documents filed by interested governmental entities that request to participate under 10 CFR 2.315(c), must be filed in accordance with the NRC's E-Filing rule (72 FR 49139; August 28, 2007, as amended at 77 FR 46562, August 3, 2012). The E-Filing process requires participants to submit and serve all adjudicatory documents over the internet, or in some cases to mail copies on electronic storage media. Detailed guidance on making electronic submissions may be found in the Guidance for Electronic Submissions to the NRC and on the NRC's website at *http://www.nrc.gov/site-help/e-submittals.html.* Participants may not submit paper copies of their filings unless they seek an exemption in accordance with the procedures described below.

To comply with the procedural requirements of E-Filing, at least 10 days prior to the filing deadline, the participant should contact the Office of the Secretary by email at *hearing.docket@nrc.gov,* or by telephone at 301–415–1677, to request (1) a digital identification (ID) certificate, which allows the participant (or its counsel or representative) to digitally sign submissions and access the E-Filing system for any proceeding in which it is participating; and (2) advise the Secretary that the participant will be submitting a request or other adjudicatory document (even in instances in which the participant, or its counsel or representative, already holds an NRC-issued digital ID certificate). Based upon this information, the Secretary will establish an electronic docket for the hearing in this proceeding if the Secretary has not already established an electronic docket.

Information about applying for a digital ID certificate is available on the NRC's public website at *http://www.nrc.gov/site-help/e-submittals/getting-started.html.* Once a participant has obtained a digital ID certificate and a docket has been created, the participant can then submit adjudicatory documents. Submissions must be in Portable Document Format (PDF). Additional guidance on PDF submissions is available on the NRC's public website at *http://www.nrc.gov/site-help/electronic-sub-ref-mat.html.* A filing is considered complete at the time the document is submitted through the NRC's E-Filing system. To be timely, an electronic filing must be submitted to the E-Filing system no later than 11:59 p.m. Eastern Time on the due date. Upon receipt of a transmission, the E-Filing system time-stamps the document and sends the submitter an email notice confirming receipt of the document. The E-Filing system also distributes an email notice that provides access to the document to the NRC's Office of the General Counsel and any others who have advised the Office of the Secretary that they wish to participate in the proceeding, so that the filer need not serve the document on those participants separately. Therefore, applicants and other participants (or their counsel or representative) must apply for and receive a digital ID certificate before adjudicatory documents are filed so that they can obtain access to the documents via the E-Filing system.

A person filing electronically using the NRC's adjudicatory E-Filing system may seek assistance by contacting the NRC's Electronic Filing Help Desk through the ''Contact Us'' link located on the NRC's public website at *http://www.nrc.gov/site-help/e-submittals.html,* by email to *MSHD.Resource@nrc.gov,* or by a toll-free call at 1–866–672–7640. The NRC Electronic Filing Help Desk is available between 9 a.m. and 6 p.m., Eastern Time, Monday through Friday, excluding government holidays.

Participants who believe that they have a good cause for not submitting documents electronically must file an exemption request, in accordance with 10 CFR 2.302(g), with their initial paper filing stating why there is good cause for not filing electronically and requesting authorization to continue to submit documents in paper format. Such filings must be submitted by: (1) First class mail addressed to the Office of the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001, Attention: Rulemaking and Adjudications Staff; or (2) courier, express mail, or expedited delivery service to the Office of the Secretary, 11555 Rockville Pike, Rockville, Maryland 20852, Attention: Rulemaking and Adjudications Staff. Participants filing adjudicatory documents in this manner are responsible for serving the document on all other participants. Filing is considered complete by first-class mail as of the time of deposit in the mail, or by courier, express mail, or expedited delivery service upon depositing the document with the provider of the service. A presiding officer, having granted a request for exemption from using E-Filing, may require a participant or party to use E-Filing if the presiding officer subsequently determines that the reason for granting the exemption from use of E-Filing no longer exists.

Documents submitted in adjudicatory proceedings will appear in the NRC's electronic hearing docket which is available to the public at *https://adams.nrc.gov/ehd,* unless excluded pursuant to an order of the Commission or the presiding officer. If you do not have an NRC-issued digital ID certificate as described above, click cancel when the link requests certificates and you will be automatically directed to the NRC's electronic hearing dockets where you will be able to access any publicly available documents in a particular hearing docket. Participants are requested not to include personal privacy information, such as social security numbers, home addresses, or personal phone numbers in their filings, unless an NRC regulation or other law requires submission of such information. For example, in some instances, individuals provide home addresses in order to demonstrate proximity to a facility or site. With respect to copyrighted works, except for limited excerpts that serve the purpose of the adjudicatory filings and would constitute a Fair Use application, participants are requested not to include copyrighted materials in their submission.

Detailed information about the subsequent license renewal process can be found under the Nuclear Reactors icon at *http://www.nrc.gov/reactors/operating/licensing/renewal.html* on the NRC's website. Copies of the application to renew the operating licenses for Turkey Point are available for public inspection at the NRC's PDR, and at *https://www.nrc.gov/reactors/operating/licensing/renewal/subsequent-license-renewal.html,* the NRC's website while the application is under review. The application may be accessed in ADAMS through the NRC Library on the internet at *http://www.nrc.gov/reading-rm/adams.html* under ADAMS Accession No. ML18113A132. As stated above, persons who do not have access to ADAMS or who encounter problems in accessing the documents located in ADAMS may contact the NRC's PDR reference staff by telephone at 1–800–397–4209 or 301–415–4737, or by email to *pdr.resources@nrc.gov.*

The NRC staff has verified that a copy of the SLRA is also available for inspection near the site at the Homestead Branch Library, 700 North Homestead Boulevard, Homestead, Florida 33030; South Dade Regional Library, 10750 SW 211th Street, Miami, Florida 33189; Naranja Branch Library, 14850 SW 280 St., Homestead, Florida 33032; and Main Library, 101 West Flagler St., Miami, Florida 33130.

Dated at Rockville, Maryland, this 27th day of April 2018.

For the Nuclear Regulatory Commission.

Eric R. Oesterle,

Chief, License Renewal Project Branch, Division of Materials and License Renewal, Office of Nuclear Reactor Regulation.

[FR Doc. 2018–09279 Filed 5–1–18; 8:45 am]

BILLING CODE 7590–01–P

NUCLEAR REGULATORY COMMISSION

[Docket Nos. 52–029 and 52–030; NRC–2008–0558]

Duke Energy Florida, LLC; Levy Nuclear Plant, Units 1 and 2

AGENCY: Nuclear Regulatory Commission.

ACTION: Termination of licenses.

SUMMARY: The U.S. Nuclear Regulatory Commission (NRC) is terminating the Levy Nuclear Plant (LNP) Units 1 and 2 Combined Licenses (COLs) designated as NPF–99 and NPF–100 and their included licenses to manufacture, produce, transfer, receive, acquire, own, possess, or use byproduct material. By letter dated January 25, 2018, Duke Energy Florida, LLC (Duke) requested that the NRC terminate the LNP COLs. Construction was not initiated for LNP Units 1 and 2, and nuclear materials were never procured or possessed under these licenses. Consequently, the LNP site is approved for unrestricted use.

DATES: The termination was issued on April 26, 2018.

BEFORE THE UNITED STATES

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of)
)
) Docket No. 50-250
) Docket No. 50-251
(Turkey Point Nuclear Power Plant, Units 3 and 4)

(Subsequent License Renewal Application)

DECLARATION OF Anne Hemingway Feuer

I, Anne Hemingway Feuer, declare as follows:

1. I am a resident of Cutler Bay, Florida. I own a house at 18661 Belview Drive Lane and have resided at this house with my wife since May, 1991. We raised two daughters in this home, though currently only my husband Bill and I reside at 18661 Belview Drive.
2. I am currently a member of Friends of the Earth ("FoE"), and have been a member since 1979. As a resident of Florida's Miami-Dade county, I am particularly interested in and

support FoE's work related to Florida Power and Light Company (FPL) and their Turkey Point Power Plant ("Turkey Point") reactors.

3. Among its missions, FoE seeks to ensure that the public has an opportunity to influence the outcome of governmental and corporate decisions that affect the lives of many people, including myself.

4. My home is about 5 miles from Turkey Point. I am an RN Care Manager for AIDS Healthcare Foundation, gardener and a glass/clay artist in my spare time

5. I live with my husband Bill Feuer, who does Biostatistics for the University of Miami Bascom Palmer Eye Institute and enjoys playing guitar and creating music in his spare time. We both enjoy working from home at least half time on our computer based home offices. An accicident at Turkey Point would mean that we would no longer be able to enjoy fresh avocados, mangoes, carambolas, bananas, tomatoes and pineapples that grow in our yard as the prevailing wind blows straight off the ocean from Turkey Point. We would no longer be able to live where we do, as that same wind hits our home at 18661 Belview Drive, Cutler Bay.

6. I am concerned that the continued operation of Turkey Point for an additional 20 years beyond the term of its original license and the additional 20 year relicense renewal period will jeopardize the health and safety of my family and myself and the value of our property. I am also concerned that the operation of Turkey Point will have an adverse effect on the health of the environment in which I live.

7. My personal health and safety and my family's personal health and safety will be seriously affected in the event that Turkey Point is damaged by sea level rise, storm surge, hurricanes or other accidents, causing a radiation leak from the plant.

8. Turkey Point's operation without adequate assurance that its essential structures will continue to operate and that the plant can be safely shut down in the event of flooding or storm related power outages and damage poses a significant risk to my personal health and safety. I am particularly worried about the consequences that an accident at Turkey Point would cause for my daughter, as very young, developing children are at greater risk for radiation-related health problems than adults.

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9. The value of my home - a three-bedroom, two-bath house with surrounding green space and gardens - will be adversely affected in the event of an earthquake/hurricane and subsequent release or threatened release of radioactivity at Turkey Point. The value of our home offices and creative space and our assets will be adversely affected in the event of a flood or accident or threatened release of radioactivity from Turkey Point because the local community will not want to purchase property with mature fruit trees and a garden near such a potential calamity.

10. My husband and I love to walk and bike out at Black Point Marina, and down in Everglades National Park. We are concerned about reports of heightened tritium from Turkey Point in our local waters. Continued operation of the Turkey Point reactors will only increase these contamination problems and threaten my use and enjoyment of the environment near the reactors and an accident at Turkey Point would destroy my ability to continue recreational activities in this area. We enjoy eating local seafood at Golden Rule and Captain's Tavern, and would be very distressed if this was no longer an option due to radioactive contamination of local fish.

11. The whole of Miami-Dade County surrounding Turkey Point would be financially ruined following any disaster at the plant, not to mention that the health and safety of my family and neighbors would be in jeopardy. Tourism is the economic backbone of Miami-Dade County and would be severely impacted if not completely destroyed in the event of an accident at Turkey Point. Agriculture is another leading economic force in our county. The integrity of agricultural land would certainly be spoiled by an accident at Turkey Point.

12. As a member of 350.com and Urban Paradise Guild and Awake Miami/Labor and Community Alliance of South Florida since 2015, I've been involved in several efforts to protect and restore the coastal environment surrounding Turkey Point. I have supported Cleo Institute's work and Oceana's work to establish a Marine Sanctuary in Biscayne Bay, and I've been active in protesting contamination from Turkey Point.

13. The continued operation of Turkey Point for an additional 20 years without ensuring that the aging plant can withstand foreseeable accidents, natural disasters and climate change

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impacts poses a significant risk to my personal health and safety, the health and safety of my family, the market value of my home and business, and my interest in using and protecting the environment around Turkey Point.

14. I authorize FoE to petition to intervene in this proceeding on my behalf. I authorize FoE to represent my interests in any hearing on the license renewal request.

15. I strongly support the petition to intervene filed by FoE with the Nuclear Regulatory Commission regarding Turkey Point.

I declare, under penalty of perjury, that the foregoing information is true, accurate, and correct. Executed on 29th June, in 2018..

Anne E. Hemingway Feuer

Anne Hemingway Feuer

18661 Belview Drive, Cutler Bay, FL 33157

**BEFORE THE UNITED STATES
NUCLEAR REGULATORY COMMISSION**

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
	)	Docket No. 50-250
	)	Docket No. 50-251
(Turkey Point Nuclear Power Plant, Units 3 and 4	)	

(Subsequent License Renewal Application)

DECLARATION OF Laura Bauman

I, Laura Bauman, declare as follows:

1. I am a resident of Key Largo, Florida. I own a house at 404 Thumper Thoroughfare and have resided at this house with my significant other since 2009. We are raising one daughter in this home. All three of us reside at the 404 Thumper Thoroughfare address.
2. I am currently a member of Friends of the Earth ("FoE"). As a resident of Florida's Monroe County, I am particularly interested in and support FoE's work related to Florida Power and Light Company (FPL) and their Turkey Point Power Plant ("Turkey Point") reactors.
3. Among its missions, FoE seeks to ensure that the public has an opportunity to influence the outcome of governmental and corporate decisions that affect the lives of many people, including myself.
4. My home is about 41 miles from Turkey Point. I am a wetland ecologist that works in the Everglades and Florida Bay. My significant other is a mooring buoy specialist that works on the coral reef tract in the Florida Keys National Marine Sanctuary. We both rely on the health and vitality of our local waters for employment.
5. An accident at Turkey Point would mean that my family could not live and work in Key Largo, temporarily or permanently depending on the severity of the contamination. My child could not attend school. We would be forced to evacuate.

6. I am concerned that the continued operation of Turkey Point for an additional 20 years beyond the term of its original license and the additional 20 year relicense renewal period will jeopardize the health and safety of my family and myself and the value of our property. I am also concerned that the operation of Turkey Point will have an adverse effect on the health of the environment in which I live.
7. My personal health and safety and my family's personal health and safety will be seriously affected in the event that Turkey Point is damaged by sea level rise, storm surge, hurricanes or other accidents, causing a radiation leak from the plant.
8. Turkey Point's operation without adequate assurance that its essential structures will continue to operate and that the plant can be safely shut down in the event of flooding or storm related power outages and damage poses a significant risk to my personal health and safety. I am particularly worried about the consequences that an accident at Turkey Point would cause for my daughter, as young, developing children are at greater risk for radiation-related health problems than adults.
9. The value of my home - a three-bedroom, two-bath house with surrounding green space- will be adversely affected in the event of an earthquake and subsequent release or threatened release of radioactivity at Turkey Point.
10. I have been an avid diver since 2000 and have regularly swum waters in the Florida Keys for almost 20 years. I am concerned about reports of heightened tritium from Turkey Point in our local waters, including our fragile drinking water that comes from the Biscayne aquifer. Continued operation of the Turkey Point reactors will only increase these contamination problems and threaten my use and enjoyment of the environment. An accident at Turkey Point would destroy my ability to continue recreational activities in this area, as well as threaten my drinking water supply.
11. Monroe County has a very real threat to be financially ruined following any disaster at the plant, not to mention that the health and safety of my family and neighbors would be in jeopardy. Tourism is the economic backbone of Monroe County and would be severely impacted if not completely destroyed in the event of an accident at Turkey Point.
12. The continued operation of Turkey Point for an additional 20 years without ensuring that the aging plant can withstand foreseeable accidents, natural disasters and climate change impacts poses a significant risk to my personal health and safety, the health and safety of

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my family, the market value of my home, and my interest in using and protecting the environment around Turkey Point.

13. I authorize FoE to petition to intervene in this proceeding on my behalf. I authorize FoE to represent my interests in any hearing on the license renewal request.
14. I strongly support the petition to intervene filed by FoE with the Nuclear Regulatory Commission regarding Turkey Point.

I declare, under penalty of perjury, that the foregoing information is true, accurate, and correct. Executed on July 30, in 2018.

Laura Bauman

Laura Bauman

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BEFORE THE UNITED STATES
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
	)	Docket No. 50-250
	)	Docket No. 50-251
(Turkey Point Nuclear Power Plant, Units 3 and 4	)	

(Subsequent License Renewal Application)

DECLARATION OF VICKI MCGEE-ABSTEN

I, Vicki McGee-Absten, declare as follows:

1. I am a resident of Key Largo, Florida. I rent a house from my father at 980 Oleander Rd and have resided at this house with my two sons since 2013.
2. I am currently a member of Friends of the Earth ("FoE"). As a resident of Florida's Monroe County, I am particularly interested in and support FoE's work related to Florida Power and Light Company (FPL) and their Turkey Point Power Plant ("Turkey Point") reactors.
3. Among its missions, FoE seeks to ensure that the public has an opportunity to influence the outcome of governmental and corporate decisions that affect the lives of many people, including myself.
4. My home is about 35 miles from Turkey Point. I am a marine bioogist that works in the Florida Bay. As a biologist I rely on the health and vitality of our local waters for employment.
5. An accident at Turkey Point would mean that my family could not live and work in Key Largo, temporarily or permanently depending on the severity of the contamination. My children could not attend school. We would be forced to evacuate.
6. I am concerned that the continued operation of Turkey Point for an additional 20 years beyond the term of its original license and the additional 20 year relicense renewal period

will jeopardize the health and safety of my family and myself and the value of our property. I am also concerned that the operation of Turkey Point will have an adverse effect on the health of the environment in which I live.

7. My personal health and safety and my family's personal health and safety will be seriously affected in the event that Turkey Point is damaged by sea level rise, storm surge, hurricanes or other accidents, causing a radiation leak from the plant.
8. Turkey Point's operation without adequate assurance that its essential structures will continue to operate and that the plant can be safely shut down in the event of flooding or storm related power outages and damage poses a significant risk to my personal health and safety. I am particularly worried about the consequences that an accident at Turkey Point would cause for my daughter, as young, developing children are at greater risk for radiation-related health problems than adults.
9. The value of my home - a three-bedroom, two-bath house with surrounding green space- will be adversely affected in the event of an earthquake and subsequent release or threatened release of radioactivity at Turkey Point.
10. I am a native Floridian and have enjoyed the local waters my entire life (50 years) and have watched the reef deteriorate over my life time due to climate change, global warming coral bleaching and pollution run off. I am concerned about reports of heightened tritium from Turkey Point in our local waters, including our fragile drinking water that comes from the Biscayne aquifer. Continued operation of the Turkey Point reactors will only increase these contamination problems and threaten my use and enjoyment of the environment. An accident at Turkey Point would destroy my ability to continue recreational activities in this area, as well as threaten my drinking water supply.
11. Monroe County has a very real threat to be financially ruined following any disaster at the plant, not to mention that the health and safety of my family and neighbors would be in jeopardy. Tourism is the economic backbone of Monroe County and would be severely impacted if not completely destroyed in the event of an accident at Turkey Point.
12. The continued operation of Turkey Point for an additional 20 years without ensuring that the aging plant can withstand foreseeable accidents, natural disasters and climate change impacts poses a significant risk to my personal health and safety, the health and safety of my family, the market value of my home, and my interest in using and protecting the

environment around Turkey Point. South Florida needs to be at the fore front of global warming and sea level rise. Alternative energy sources especially in such environmentally sensitive areas are a must.

13. I authorize FoE to petition to intervene in this proceeding on my behalf. I authorize FoE to represent my interests in any hearing on the license renewal request.
14. I strongly support the petition to intervene filed by FoE with the Nuclear Regulatory Commission regarding Turkey Point.

I declare, under penalty of perjury, that the foregoing information is true, accurate, and correct. Executed on July 30, in 2018.

Vicki McGee-Absten

Vicki McGee-Absten

BEFORE THE UNITED STATES
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
	)	Docket No. 50-250
	)	Docket No. 50-251
(Turkey Point Nuclear Power Plant, Units 3 and 4	)	

(Subsequent License Renewal Application)

DECLARATION

I, Patricia J. Wynn, declare as follows:

1. I am a resident of Miami, Florida. I own a house at 11781 SW 91st Terrace and have resided at this house with my husband since 1982. Currently only my husband I reside at this address.
2. I am currently a member of Friends of the Earth ("FoE"), and have been a member since 2018. As a resident of Florida's Miami-Dade county, I am particularly interested in and support FoE's work related to Florida Power and Light Company (FPL) and their Turkey Point Power Plant ("Turkey Point") reactors.
3. Among its missions, FoE seeks to ensure that the public has an opportunity to influence the outcome of governmental and corporate decisions that affect the lives of many people, including myself.
4. My home is about 20 miles from Turkey Point. I am a real estate broker specializing in commercial property leasing and management. My husband is a web-site designer and musician.
5. I am concerned that the continued operation of Turkey Point for an additional 20 years beyond the term of its original license and the additional 20 year relicense renewal period will jeopardize the health and safety of ourselves as well as our neighbors, which would ultimately impact the value of our property. I am also concerned that the operation of

Turkey Point will have an adverse effect on the health of the environment in which we live.

6. My personal health and safety and that of my husband's will be seriously affected in the event that Turkey Point is damaged by sea level rise, storm surge, hurricanes or other accidents, causing a radiation leak from the plant.
7. Turkey Point's operation without adequate assurance that its essential structures will continue to operate and that the plant can be safely shut down in the event of flooding or storm related power outages and damage poses a significant risk to my personal health and safety. I am particularly worried about the consequences that an accident at Turkey Point would cause for young developing children, which are at greater risk for radiation-related health problems than adults.
8. The value of my home - a three-bedroom, three-bath townhome with surrounding green space, gardens and a shed - will be adversely affected in the event of an earthquake and subsequent release or threatened release of radioactivity at Turkey Point. The value of my business and my husband's will be adversely affected in the event of a flood or accident or threatened release of radioactivity from Turkey Point because the local market will have changed for the commercial real estate industry.
9. I have been an avid windsurfer since 1978 and have regularly windsurfed waters near Turkey Point since 1993, over 20 years. I am concerned about reports of heightened tritium from Turkey Point in our local waters. Continued operation of the Turkey Point reactors will only increase these contamination problems and threaten my use and enjoyment of the environment near the reactors and an accident at Turkey Point would destroy my ability to continue recreational activities in this area.
10. The whole of Miami-Dade County surrounding Turkey Point would be financially ruined following any disaster at the plant, not to mention that the health and safety of my family and neighbors would be in jeopardy. Tourism is the economic backbone of Miami-Dade County and would be severely impacted if not completely destroyed in the event of an accident at Turkey Point. Agriculture is another leading economic force in our county. The integrity of agricultural land would certainly be spoiled by an accident at Turkey Point.

11. The continued operation of Turkey Point for an additional 20 years without ensuring that the aging plant can withstand foreseeable accidents, natural disasters and climate change impacts poses a significant risk to my personal health and safety, the health and safety of my family, the market value of my home and business, and my interest in using and protecting the environment around Turkey Point.
12. I authorize FoE to petition to intervene in this proceeding on my behalf. I authorize FoE to represent my interests in any hearing on the license renewal request.
13. I strongly support the petition to intervene filed by FoE with the Nuclear Regulatory Commission regarding Turkey Point.

I declare, under penalty of perjury, that the foregoing information is true, accurate, and correct.

Executed on _July 31, 2018_, in _Miami-Dade County_.

Patricia J. Wynn

Patricia J. Wynn
11781 SW 91st Terrace, Miami, FL 33186

BEFORE THE UNITED STATES
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
	)	Docket No.
	)	Docket No.
(Turkey Point Nuclear Power Plant, Units 3 and 4	)	

(Subsequent License Renewal Application)

DECLARATION OF JONATHAN LESTER FRIED

I, Jonathan Lester Fried, declare as follows:

1. I am a resident of Homestead, Florida. I own a house at 715 NW 9th Court and have resided at this house since 2002.
2. I am currently a member of Friends of the Earth ("FoE"), and have been a member since 2018. As a resident of Florida's Miami-Dade county, I am particularly interested in and support FoE's work related to Florida Power and Light Company (FPL) and their Turkey Point Power Plant ("Turkey Point") reactors.
3. Among its missions, FoE seeks to ensure that the public has an opportunity to influence the outcome of governmental and corporate decisions that affect the lives of many people, including myself.
4. My home is about 12 miles from Turkey Point. I am the executive director of WeCount!, Inc., a non-profit organization in Homestead. My workplace is about 11 miles from Turkey Point.
5. I am concerned that an accident at Turkey Point would mean the community where I reside and work would longer be able a viable place to live for myself and my friends and neighbors.
6. I am concerned that the continued operation of Turkey Point for an additional 20 years beyond the term of its original license and the additional 20 year relicense renewal period will jeopardize my health and safety, and that of my friends and neighbors. I am also

concerned that the operation of Turkey Point will have an adverse effect on the health of the environment in which I live.

7. My personal health and safety and that of my neighbors and friends will be seriously affected in the event that Turkey Point is damaged by sea level rise, storm surge, hurricanes or other accidents, causing a radiation leak from the plant.
8. Turkey Point's operation without adequate assurance that its essential structures will continue to operate and that the plant can be safely shut down in the event of flooding or storm related power outages and damage poses a significant risk to my personal health and safety.
9. The value of my home - a three-bedroom, two-bath house with surrounding green space, garden, and shed - will be adversely affected in the event of an earthquake and subsequent release or threatened release of radioactivity at Turkey Point.
10. One of the joys of living in South Miami-Dade County is the enjoyment of the beautiful natural environment. I am concerned about reports of heightened tritium from Turkey Point in our local waters. Continued operation of the Turkey Point reactors will only increase these contamination problems and threaten my use and enjoyment of the environment near the reactors and an accident at Turkey Point would destroy my ability to continue recreational activities in this area.
11. The whole of Miami-Dade County surrounding Turkey Point would be financially ruined following any disaster at the plant, not to mention that my health and safety, and that of my friends and neighbors would be in jeopardy. Tourism is the economic backbone of Miami-Dade County and would be severely impacted if not completely destroyed in the event of an accident at Turkey Point.
12. Agriculture is another leading economic force in our county. The integrity of agricultural land would certainly be spoiled by an accident at Turkey Point. Many of the members of the organization where I work are farm and plant nursery workers. Their livelihood would disappear in the event of an accident at Turkey Point.
13. The continued operation of Turkey Point for an additional 20 years without ensuring that the aging plant can withstand foreseeable accidents, natural disasters and climate change impacts poses a significant risk to my personal health and safety, the market value of my

home, my livelihood, and my interest in using and protecting the environment around Turkey Point.

14. I authorize FoE to petition to intervene in this proceeding on my behalf. I authorize FoE to represent my interests in any hearing on the license renewal request.
15. I strongly support the petition to intervene filed by FoE with the Nuclear Regulatory Commission regarding Turkey Point.

I declare, under penalty of perjury, that the foregoing information is true, accurate, and correct.
Executed on July 31, 2018, in Homestead, Florida.

Jonathan Lester Fried

BEFORE THE UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of

FLORIDA POWER & LIGHT COMPANY Docket Nos. 50-250, 50-251

Turkey Point Nuclear Generating Station, Units 3 and 4)

DECLARATION OF PETER STOCKER

I, Peter Stocker, hereby declare as follows:

1. The facts set forth in this declaration are based on my personal knowledge.

2. I am the Vice President of Membership and Development of Friends of the Earth. I have served in that position since January 2017. Friends of the Earth is a tax exempt, nonprofit environmental advocacy organization founded in 1969. Friends of the Earth is headquartered and incorporated in the District of Columbia and has an office in Berkeley, California. I am also a member of Friends of the Earth.

3. I am familiar with the organization's mission, which is to defend the environment and create a more healthy and just world. One aspect of that mission is to engage in efforts to improve the environmental, health, and safety conditions at civil nuclear facilities licensed by the Nuclear Regulatory Commission and its predecessor agencies and oppose proposals to design and build new reactors subsidized with federal funds. To that end, Friends of the Earth utilizes its institutional resources, including legislative advocacy, litigation, and public outreach and education, to minimize the risks that nuclear facilities pose to its members and to the general public.

4. Friends of the Earth is a part of Friends of the Earth International, a federation of grassroots groups working in 74 countries on today's most urgent environmental and social issues. Friends of the Earth International is the world's largest grassroots environmental federation. In the United States, Friends of the Earth has more than 100,000 members in all 50 states, 4,800 of those members are in Florida. In addition to dues paying members, Friends of the Earth has 1.49 million online activist supporters across the country with 72,000 of them in Florida.

5. Friends of the Earth relies on sound science and uses the law to advocate innovative strategies to conserve natural resources and protect public health and the environment. Friends of the Earth is engaged in a number of efforts before the Nuclear Regulatory Commission (NRC) to improve operating nuclear facilities and oppose new proposals and in litigation to support these efforts. The instant petition and request for a hearing in the NRC proceeding regarding Turkey Point, is an integral part of our advocacy to address the environmental, health and safety impacts from Turkey Point.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge, information, and belief.

Executed at Browns Valley, California, on July 31, 2018

Peter Stocker

Peter Stocker
Vice President, Membership and Development
Friends of the Earth

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	
FLORIDA POWER & LIGHT COMPANY	)	Docket No. 50-250
	)	Docket No. 50-251
(Turkey Point Nuclear Generating Station, Unit Nos. 3 and 4)	)	August 1, 2018
	)	
(Subsequent License Renewal Application)	)	

REQUEST FOR HEARING AND PETITION TO INTERVENE SUBMITTED BY FRIENDS OF THE EARTH, NATURAL RESOURCES DEFENSE COUNCIL, AND MIAMI WATERKEEPER

PRELIMINARY STATEMENT

Friends of the Earth, Inc. ("FOE"), Natural Resources Defense Council, Inc. ("NRDC"), and Miami Waterkeeper, Inc. ("Miami Waterkeeper") (collectively, "Petitioners") hereby submit this hearing request and petition to intervene in the Nuclear Regulatory Commission ("NRC") subsequent relicensing proceeding that will determine whether Turkey Point Nuclear Generation Station, Unit Nos. 3 and 4 ("Turkey Point"), will be licensed to operate until 2052 and 2053, respectively. Florida Power & Light Company ("Applicant" or "FPL") owns and operates Turkey Point. These units have operated since the early 1970s adjacent to the Florida Everglades, Biscayne Bay, and several population centers on South Florida's Atlantic coast.

STANDING

Friends of the Earth

FOE is a national non-profit environmental organization headquartered and incorporated in the District of Columbia with an office in Berkeley, California.[1] FOE has a nationwide membership of over 100,000 (including approximately 4,800 members in Florida) and 1.49 million online activists.[2] FOE seeks to defend the environment and create a more healthy and just world.[3] Since its inception in 1969, FOE has sought to improve the environmental, health, and safety conditions at civil nuclear facilities licensed by the NRC and its predecessor agencies.[4] To that end, FOE utilizes its institutional resources, including legislative advocacy, litigation, and public outreach and education, to minimize the risks that nuclear facilities pose to its members and to the general public.

Anne Hemingway Feuer is a member of FOE and lives in Cutler Bay, Florida, approximately five miles from Turkey Point.[5] Ms. Feuer and her husband frequently work from home and grow avocados, mangoes, carambolas, bananas, tomatoes and pineapples in their yard. Ms. Feuer and her husband enjoy walking and biking at Black Point Marina and in Everglades National Park, as well as eating local seafood. Ms. Feuer is concerned about the continued operation of Turkey Point for an additional 20 years without adequate analysis of Turkey Point's environmental impacts.[6] Prevailing winds blow off the ocean from Turkey Point toward Ms. Feuer's home. An accident at Turkey Point would personally and significantly affect Ms. Feuer

[1] Declaration of Peter Stocker (Attachment A) at ¶ 2.
[2] *Id.* at ¶ 4.
[3] *Id.* at ¶ 3.
[4] *Id.* at ¶¶ 3, 5.
[5] Declaration of Anne Hemingway Feuer (Attachment B) at ¶¶ 1, 4.
[6] *Id.* at ¶¶ 6-8.

and her husband. An accident would affect the value of Ms. Feuer's home, would prevent Ms. Feuer from enjoying the fresh fruits that grow in our yard, and, in the event of a radiation leak, would cause significant harm to Ms. Feuer's health and safety.[7]

Laura Bauman is a member of FOE and lives in Key Largo, Florida, approximately 41 miles from Turkey Point.[8] Ms. Bauman is a wetland ecologist who works in the Everglades and Florida Bay.[9] As an avid diver, Ms. Bauman has regularly swum in the waters around Turkey Point for nearly 20 years.[10] An accident at Turkey Point would personally affect Ms. Bauman and her family.[11] Ms. Bauman and her family could not live or work in Key Largo, and may be forced to evacuate.[12] An accident would adversely affect her drinking water source, as well as her ability to continue diving near Turkey Point.[13]

Vicki McGee-Absten is a member of FOE and lives in Key Largo, Florida, approximately 35 miles from Turkey Point.[14] An accident at Turkey Point would seriously affect Ms. McGee-Absten's and her family's health and safety.[15] Ms. McGee-Absten and her family could not live or work in Key Largo, and may be forced to evacuate.[16] Ms. McGee-Absten has enjoyed recreating in waters near Turkey Point for approximately 50 years. She is concerned

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[7] *Id.* at ¶ 7, 9, 13.
[8] Declaration of Laura Bauman (Attachment C) at ¶¶ 1, 4.
[9] *Id.* at ¶ 4.
[10] *Id.* at ¶ 10.
[11] *Id.* at ¶¶ 6-8.
[12] *Id.* at ¶ 5.
[13] *Id.* at ¶ 10.
[14] Declaration of Vicki McGee-Absten (Attachment D) at ¶¶ 1, 4.
[15] *Id.* at ¶¶ 6-8, 12.
[16] *Id.* at ¶ 5.

about the effects of tritium pollution on the local watershed, and specifically on her ability to recreate near Turkey Point and her access to clean drinking water.[17] The continued operation of Turkey Point for an additional 20 years without ensuring that the aging plant can withstand foreseeable accidents, natural disasters and climate change impacts poses a significant risk to Ms. McGee-Absten's and her family's personal health and safety, the market value of her home, and her interest in using and protecting the environment around Turkey Point.[18]

Patricia J. Wynn is a member of FOE and lives in Miami, Florida, approximately 20 miles from Turkey Point.[19] Ms. Wynn has been an avid windsurfer since 1978, and has regularly windsurfed waters near Turkey Point for over 20 years. Ms. Wynn is concerned about reports of heightened tritium pollution from Turkey Point.[20] She is concerned that continued operation of Turkey Point during the subsequent license renewal period will threaten her ability to safely recreate in the environment around Turkey Point.[21] An accident at Turkey Point would personally affect Ms. Wynn.[22]

Jonathan Lester Fried, a member of FOE, lives in Homestead, Florida, approximately 12 miles from Turkey Point.[23] Mr. Fried is executive director of WeCount!, Inc., a non-profit organization in Homestead.[24] Mr. Fried enjoys recreating in the waters near Turkey Point, and

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[17] *Id.* at ¶ 10.
[18] *Id.* at ¶ 12.
[19] Declaration of Patricia J. Wynn (Attachment E) at ¶¶ 1, 4.
[20] *Id.* at ¶ 9.
[21] *Id.* at ¶ 9.
[22] *Id.* at ¶¶ 6-9, 11.
[23] Declaration of Jonathan Lester Fried (Attachment F) at ¶¶ 1, 4.
[24] *Id.* at ¶ 4.

an accident would adversely impact his ability to continue recreating there.[25] An accident at Turkey Point resulting in a radiation leak would harm Mr. Fried's personal health and safety.[26]

Natural Resources Defense Council

NRDC is a national non-profit environmental organization with offices in Washington, D.C., New York City, San Francisco, Chicago, Santa Monica, and Beijing.[27] NRDC has a nationwide membership of over 384,000 (plus hundreds of thousands of online activists), including 15,324 members in Florida, at least 1,746 members living within 50 miles of Turkey Point Units 3 and 4. Among its missions, NRDC seeks to maintain and enhance environmental quality, to safeguard the natural world for present and future generations, and to foster the fundamental right of all people to have a voice in the decisions that affect their environment. Since its inception in 1970, NRDC has sought to improve the environmental, health, and safety conditions at the nuclear facilities operated by the Department of Energy and the civil nuclear facilities licensed by the NRC and their predecessor agencies. To that end, NRDC utilizes its institutional resources, including legislative advocacy, litigation, and public outreach and education, to minimize the risks that nuclear facilities pose to its members and to the general public.

Dr. Philip Stoddard is a member of NRDC and has been since 1993.[28] Dr. Stoddard lives

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[25] *Id.* at ¶¶ 7, 8, 10.
[26] *Id.* at ¶ 7.
[27] Declaration of Gina Trujillo (Attachment G) at ¶¶ 1–6.
[28] Declaration of Phillip Stoddard (Attachment H) at ¶ 2.

at 6820 SW 64th Court, South Miami, Florida, and has lived at that address for about fifteen years.[29] Dr. Stoddard's home is approximately 18 miles from Turkey Point Units 3 and 4. In his capacity as Mayor of the City of South Miami, Florida, Dr. Stoddard has toured Turkey Point Units 3 and 4 and has studied issues related to flooding, evacuation, environmental problems related to the cooling canal system, and other issues at Turkey Point Units 3 and 4.[30] Due to the location of Dr. Stoddard's home within the 50-mile emergency planning zone for the ingestion pathway, Dr. Stoddard is concerned that an accident at Turkey Point Units 3 and 4 would result in dangerous airborne levels of radioiodines and increased risk of radiation-induced thyroid cancers. He is concerned by the lack of a plan to distribute potassium iodide prophylaxis to the vulnerable population before airborne exposure to radioiodines.[31] Dr. Stoddard is personally familiar with FPL's "shelter-in-place" plan in the event of a radiation emergency. Dr. Stoddard is concerned that the plan, which calls for residents to stay in their homes and tape over door seams and A/C vents to prevent radiation exposure, is unreasonable and unworkable.[32]

Miami Waterkeeper

Miami Waterkeeper is a Florida non-profit organization with a mission to defend, protect, and preserve the aquatic integrity of South Florida's watershed and wildlife through citizen involvement and community action.[33] Miami Waterkeeper seeks to eliminate or mitigate threats

[29] *Id*. at ¶ 3.
[30] *Id.* at ¶¶ 5-6.
[31] *Id.* at ¶ 8.
[32] *Id.* at ¶ 7.
[33] Declaration of Rachel Silverstein, Ph.D (Attachment I) at ¶ 2.

to South Florida's coastal waters. Miami Waterkeeper works to ensure a clean and vibrant South Florida watershed and coastal culture for future generations. Miami Waterkeeper uses education, community outreach, and legal advocacy to protect South Florida's marine ecosystems, marine life, and coral reefs.[34] Miami Waterkeeper is a member of the Waterkeeper Alliance, an international organization uniting more than 190 Waterkeeper affiliates across the world. Miami Waterkeeper has approximately 100 members.

Rachel Silverstein, Ph.D lives approximately 30 miles from Turkey Point.[35] Dr. Silverstein is the Executive Director of Miami Waterkeeper, as well as a member of Miami Waterkeeper and the Waterkeeper Alliance, and a member of NRDC. Dr. Silverstein holds a Ph.D. in the Department of Marine Biology and Fisheries from the University of Miami's Rosenstiel School for Marine and Atmospheric Science.[36] In her role at Miami Waterkeeper, Dr. Silverstein patrols the bays, monitors and tests water quality, investigates pollution problems, enforces state and federal environmental laws and works with government officials and civic leaders to develop better environmental policy.[37] Dr. Silverstein enjoys boating in southern Biscayne Bay, as well as scuba diving, snorkeling, and camping in Biscayne National Park and the Florida Keys National Marine Sanctuary. Along with her family, Dr. Silverstein frequently visits Everglades National Park. Dr. Silverstein plans to continue visiting nearby national parks

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[34] *Id.* at ¶ 2
[35] *Id.* at ¶ 8.
[36] *Id.* at ¶ 3.
[37] *Id.* at ¶ 3.

and marine sanctuaries, and enjoying viewing the unique wildlife that depend on sustained fresh water flow for their habitats and lifecycles.[38] As a resident of Miami-Dade County, Dr. Silverstein relies on the Biscayne Aquifer as a primary source of drinking water. Dr. Silverstein is concerned that the hypersaline plume emanating from Turkey Point's cooling canal system is contaminating the Biscayne Aquifer.[39] If an accident happened and a radiation release occurred, Dr. Silverstein's personal safety may be at risk.[40]

Daniel Parobok is a member of Miami Waterkeeper and lives 28 miles from Turkey Point.[41] Mr. Parobok works as a biologist in Monroe County, Florida. Mr. Parobok frequently uses and enjoys the waters of South Florida, including those of Biscayne National Park and the area near Turkey Point for recreational purposes, including boating and fishing for bonefish, permit, snapper, tarpon, sheepshead, snook, and redfish.[42] Mr. Parobok frequently boats and fishes in Biscayne Bay, Card Sound, Barnes Sound, and Florida Bay. Mr. Parobok enjoys viewing wildlife such as manatees, turtles, birds, dolphins, and crocodiles when he recreates in these areas.[43] In his professional capacity, Mr. Parobok regularly conducts listed species surveys for wildlife including turtles, cara caras, queen conch, woodstorks, scrub jays, red cockaded woodpeckers, everglades snail kites, sand skinks, and gopher tortoises.[44] Mr. Parobok is

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[38] *Id.* at ¶ 6.
[39] *Id.* at ¶ 7.
[40] *Id.* at ¶ 8.
[41] Declaration of Daniel Parobok (Attachment J) at ¶¶ 4, 7.
[42] *Id.* at ¶ 4.
[43] *Id.* at ¶ 5.
[44] *Id.* at ¶ 5.

concerned that Turkey Point's cooling canal system (sometimes referred to as the "CCS") is degrading the environment that he relies upon for recreational, aesthetic, and professional purposes.[45] Mr. Parobok also relies on the Biscayne Aquifer as a primary source of drinking water. He is concerned that the hypersaline plume from Turkey Point's cooling canal system will harm his source of drinking water.[46]

Legal standards

Under the AEA, the Commission must grant a hearing on a license application upon "the request of any person whose interest may be affected by the proceeding, and shall admit any such person as a party to such proceeding."[47] To that end, a petitioner must provide the Commission with information regarding "(1) the nature of the petitioner's right under the governing statutes to be made a party; (2) the nature of the petitioner's property, financial, or other interest in the proceeding; and (3) the possible effect of any decision or order on the petitioner's interest."[48] "The NRC generally uses judicial concepts of standing in interpreting this regulation."[49] Thus, a petitioner may intervene if it can specify facts showing "that (1) it has suffered or will suffer a distinct and palpable harm constituting injury-in-fact within the zone of interests arguably protected by the governing statutes, (2) the injury is fairly traceable to the

[45] *Id.* at ¶ 7.
[46] *Id.* at ¶ 6–7.
[47] 42 U.S.C. § 2239(a)(1)(A).
[48] *Entergy Nuclear Vermont Yankee, L.L.C., and Entergy Nuclear Operations, Inc.* (Vermont Yankee Nuclear Power Station), 60 N.R.C. 548, 552 (2004) (citing 10 C.F.R. § 2.309(d)(1)).
[49] *Entergy Nuclear Vermont Yankee*, 60 N.R.C. at 552.

action being challenged, and (3) the injury will likely be redressed by a favorable determination."[50] In determining whether a petitioner has met the requirements for establishing standing, the petition is to be construed "in favor of the petitioner."[51]

Member organizations such as FOE, NRDC, and Miami Waterkeeper may intervene on behalf of their members if they can "demonstrate that the licensing action will affect at least one of [their] members, . . . identify that member by name and address, and . . . show that [they are] authorized by that member to request a hearing on his or her behalf."[52] FOE, NRDC, and Miami Waterkeeper have each supplied declarations from one or more members who reside within 50 miles of Units 3 and 4. Each declaration describes the economic, aesthetic, and environmental interests they wish to safeguard and the harms that the relicensing of Units 3 and 4 without full compliance with the law will pose to those interests.[53] Each of the Member Declarants supports this Petition, and has authorized his or her respective organization to intervene in this proceeding and request a hearing on his or her behalf.[54]

Petitioners' experts discuss in their declarations the inadequacies in the applicant's analysis of potential adverse environmental consequences of renewing the operating licenses for Units 3 and 4, including inadequate analysis of sea level rise and its impacts on the plant and

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[50] *Id.* at 552–53.
[51] *Id.* at 553 (citing *Institute of Technology* (Georgia Tech Research Reactor, Atlanta, Georgia), CLI-95-12, 42 N.R.C. 111, 115 (1995)).
[52] *Id.*
[53] *See generally* Attachments A - J.
[54] *Id.*

affected resources. These inadequacies impact Member Declarants' right to a complete and accurate assessment of the costs and benefits of the proposed action and alternatives to the proposed action.

As Member Declarants explain, they will suffer (or will be under threat of suffering) concrete and particularized injuries from the continued operations of Units 3 and 4 operations without adequate analysis of threatened environmental harms.[55] Petitioners' experts confirm the science behind these concerns: if Units 3 and 4 are not relicensed, the potential harms will not occur; and even if Units 3 and 4 are relicensed, the adverse environmental consequences caused by operations can be substantially mitigated if they are identified, analyzed and, based on that analysis, mitigated. Units 3 and 4 may not continue operations without a license from the Commission.[56] Accordingly, Turkey Point and the NRC will have caused these injuries if the proposed new operating license is issued as currently proposed. By granting Petitioners the relief they request and requiring that an adequate environmental analysis be performed, Member Declarants will obtain redress for their injuries. Even if the Applicant chooses to revise its ER to provide a legally sufficient analysis, Member Declarants will still have obtained redress: NEPA, in NRC's implementing regulations at 10 C.F.R. Parts 2 and 51, accords procedural rights to Member Declarants, whose concrete interests may be harmed by the project. By requiring FPL and the NRC staff to comply with these authorities' requirements, Member Declarants'

[55] Feuer Decl., at ¶¶ 6–8; Bauman Decl., at ¶¶ 6–8; McGee-Absten Decl., at ¶¶ 6–8; Wynn Decl., at ¶¶ 5–7; Fried Decl., at ¶¶ 7, 8, 10; Stoddard Decl., at ¶ 8; Silverstein Decl., at ¶¶ 7–9; Parobak Decl., at ¶ 7.

[56] 42 U.S.C. § 2133.

procedural rights will have been vindicated.[57]

Finally, Member Declarants have expressed concerns that fall within the zone of interests protected by NEPA and its implementing regulations.[58] Their concerns also fall within the zone of interests protected by the AEA and its implementing regulations.[59]

Member Declarants therefore have standing to intervene in their own right: they have met the requirements for injury-in-fact, causation, and redressability, and their concerns fall within the zone of interests protected by NEPA, the AEA, and their implementing regulations. They will be affected by Turkey Point's proposed relicensing and failure to provide a legally adequate environmental analysis, have provided their names and addresses, and have authorized their respective member organizations (Miami Waterkeeper, FOE, or NRDC) to intervene in this proceeding on their behalf. Thus, Petitioners have standing to pursue this action.[60]

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[57] *See Lujan v. Defenders of Wildlife*, 504 U.S. 555, 572 n.7 (1992) ("[P]rocedural rights are special: The person who has been accorded a procedural right to protect his concrete interests can assert that right without meeting all the normal standards for redressability and immediacy.") (internal quotations omitted); *see also Duke Energy Corp.* (McGuire, Units 1 and 2; Catawba, Units 1 and 2) CLI-02-17, 56 N.R.C. 1, 10 (July 23, 2002) (emphasizing NEPA's goal to "ensure that the agency does not act upon incomplete information, only to regret its decision after it is too late to correct.").

[58] *See, e.g., Ouachita Watch League v. Jacobs*, 463 F.3d 1163, 1173 (11th Cir. 2006) ("[S]ince the injury alleged is environmental, it falls within the zone of interests protected by NEPA . . . ."); *Sabine River Auth. v. U.S. Dep't of Interior*, 951 F.2d 669, 675 (5th Cir. 1992) (plaintiffs' concerns about impacts on water quality and quantity fell within NEPA's zone of interests).

[59] *Sequoyah Fuels Corp. and General Atomics* (Gore, Oklahoma Site), 39 N.R.C. 54, 75 (1994) (membership organization granted standing by showing that "the health and safety interests of its members are within the AEA-protected zone of interests"); *Babcock and Wilcox* (Apollo, Pennsylvania Fuel Fabrication Facility), 37 N.R.C. 72, 80 (1993) (holding that specified "health, safety, and environmental concerns . . . clearly come within the zone of interests safeguarded by the AEA and NEPA").

[60] *Entergy Nuclear Vermont Yankee*, 60 N.R.C. at 553.

NOTICE OF INTENT TO PARTICIPATE

Pursuant to 10 C.F.R. § 2.309 and the Notice of License Renewal Application; Opportunity to Request a Hearing and to Petition for Leave to Intervene, 83 Fed. Reg. 19,304 (May 2, 2018), Petitioners Friends of the Earth, Natural Resources Defense Council, and Miami Waterkeeper hereby submit contentions regarding FPL's application for subsequent renewal of its licenses to operate Turkey Point Units 3 and 4 for an additional 20 years, or until 2052 and 2053, respectively. As demonstrated below, these contentions should be admitted because they satisfy the NRC's admissibility requirements in 10 C.F.R. § 2.309.[61]

As noted above, at least one member of each Petitioner lives within 50 miles of the Turkey Point reactors, has authorized his or her respective member organization to represent his or her interests in environmental protection in this proceeding and, thus, pursuant to 10 C.F.R. § 2.309(d)(1), each Petitioner has standing for purposes of raising its concerns in this proceeding.

CONTENTIONS

Pursuant to 10 C.F.R. § 2.309, Petitioners set forth below the specific contentions they seek to litigate. Each contention challenges the sufficiency of the application under NRC regulations, as specified therein, as well as its compliance with NEPA. Petitioners acknowledge that, as a private entity, FPL is not directly bound by NEPA. However, pursuant to 10 C.F.R. § 2.309(f)(2), Petitioners have styled their NEPA contentions as against the ER.[62] Because an applicant's ER generally serves as the basis for the Commission's eventual Draft SEIS,

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[61] By Order of the Commission dated June 29, 2018, the time for filing a Petition to Intervene by all parties was extended to August 1, 2018.
[62] 10 C.F.R. § 2.309(f)(2) ("On issues arising under the National Environmental Policy Act, the petitioner shall file contentions based on the applicant's environmental report.").

Petitioners raise these NEPA concerns at this time in order to preserve any objections they may have if the flaws that appear in the ER also appear in the Draft SEIS. In addition, if the Draft SEIS deviates from FPL's ER in a manner to which Petitioners object, they plan to submit amended or new contentions addressing these deviations pursuant to 10 C.F.R. § 2.309(f)(2).

Each of Petitioner's contentions is within the scope of this license renewal proceeding, which is described in Parts 51 and 54.[63] A license renewal application review typically implicates issues that fall into one of two broad areas: safety/aging management issues, and public health/environmental impacts. Petitioner's contentions are focused on environmental and public health impacts.

The scope of the environmental review is defined by 10 C.F.R. Part 51, the NRC's "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," NUREG-1437 (May 1996) (the "GEIS"), and the initial hearing notice and order.[64] Some environmental issues that might otherwise be germane in a license renewal proceeding have been resolved generically for all plants and are normally, therefore, "beyond the scope of a license renewal hearing."[65] These "Category 1" issues are classified in 10 C.F.R. Part 51, Subpart A, Appendix B. Category 1 issues may be raised when a petitioner (1) demonstrates that there is new and significant information subsequent to the preparation of the GEIS regarding the environmental

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[63] *See Florida Power & Light Co.*, CLI-01-17, 54 NRC 3, 6–13 (Jul. 19, 2001); Nuclear Power Plant License Renewal, 60 Fed. Reg. 22,461 (May 8, 1995).
[64] *See, e.g., Vermont Yankee*, 64 N.R.C. at 148–49.
[65] *Turkey Point*, 54 NRC at 15; see 10 C.F.R. § 51.53(c)(3)(i).

impacts of license renewal; (2) files a petition for a rulemaking with the NRC; or (3) seeks a waiver pursuant to 10 C.F.R. § 2.335.[66]

Each of Petitioner's contentions are "material" to the findings NRC must make.[67] A "material" issue is one that would make a difference in the outcome of the proceeding.[68] "This means that there should be some significant link between the claimed deficiency and either the health and safety of the public or the environment."[69]

Each of Petitioner's contentions also demonstrate sufficient information to show that a genuine dispute exists with the Applicant on a material issue of law or fact. NRC set forth factors relevant to determining if a genuine dispute exists when it adopted the current version of 10 C.F.R. § 2.309(f)(1):

> This will require the intervenor to read the pertinent portions of the license application, including the Safety Analysis Report and the Environmental Report, state the applicant's position and the petitioner's opposing view. Where the intervenor believes the application and supporting material do not address a relevant matter, it will be sufficient for the intervenor to explain why the application is deficient.[70]

As set forth in detail in the following contentions, Petitioners satisfy the admissibility standard with respect to each contention.

CONTENTION 1-E: THE ENVIRONMENTAL REPORT FAILS TO CONSIDER A REASONABLE RANGE OF ALTERNATIVES TO THE PROPOSED ACTION, AS REQUIRED BY NEPA AND NRC

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[66] *Turkey Point*, 54 NRC at 10-12; see also 10 C.F.R. § 51.53(c)(3)(iv) (new and significant information).
[67] 10 C.F.R. § 2.309(f)(1)(iv).
[68] Rules for Practice for Domestic Licensing Proceedings—Procedural Changes in the Hearing Process, 54 Fed. Red. 33,168, 33,172 (Aug. 11, 1989).
[69] *Vermont Yankee*, 60 NRC 548, 557 (Nov. 22, 2004).
[70] 54 Fed. Reg. at 33,170.

IMPLEMENTING REGULATIONS.

1. **Statement of the issue of law or fact to be raised or controverted (10 C.F.R. § 2.309(f)(1)(i))**

The Environmental Report (§ 7.3) fails to comply with 10 C.F.R. §§ 51.45(c) and 51.53(c)(3)(iii)[71] because it fails to consider an alternative under which the existing cooling canal system would be replaced with cooling towers to reduce the well-documented adverse environmental effects related to the cooling canal system. The Environmental Report fails to include an accurate or complete analysis of "alternatives available for reducing or avoiding adverse environmental effects" and because it does not contain an adequate "consideration of alternatives for reducing adverse impacts . . . for all Category 2 license renewal issues."[72] The Environmental Report unlawfully fails to consider replacement of the canal cooling system with cooling towers as a reasonable alternative that would "reduc[e] or avoid[] adverse environmental effects" relating to numerous Category 2 issues (described below).[73]

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[71] 10 C.F.R. § 51.53(c)(3) applies to applications for an "initial renewed license," and it is unclear whether the requirements of that subsection apply to an application for a subsequent license renewal, such as the one FPL seeks here. Even if the Commission determines that § 51.53(c)(3) does not apply, Petitioners hereby rely upon 10 C.F.R. § 51.53(c)(1) and (2), which provide:

> (1) Each applicant for renewal of a license to operate a nuclear power plant under part 54 of this chapter shall submit with its application a separate document entitled 'Applicant's Environmental Report—Operating License Renewal Stage.' (2) The report must contain a description of the proposed action, including the applicant's plans to modify the facility or its administrative control procedures as described in accordance with § 54.21 of this chapter. This report must describe in detail the affected environment around the plant, the modifications directly affecting the environment or any plant effluents, and any planned refurbishment activities. In addition, the applicant shall discuss in this report the environmental impacts of alternatives and any other matters described in § 51.45.

[72] 10 C.F.R. § 51.53(c)(3)(iii).

[73] 10 C.F.R. § 51.45(c); *see also* Turkey Point Nuclear Power Plant, Units 3 and 4, Applicant's Environmental Report Subsequent Operating License Renewal Stage, ADAMS Accession No. ML18037A836 (Jan. 2018), at 7-39

1. Brief explanation of basis for the contention (10 C.F.R. § 2.309(f)(1)(ii)); concise statement of the alleged facts or expert opinions supporting the contention (10 C.F.R. § 2.309(f)(1)(v)); and statement that a genuine dispute exists with the licensee on a material issue of law or fact (10 C.F.R. § 2.309(f)(1)(vi))

The Environmental Report violates NEPA's requirement that each NEPA document consider a range of reasonable alternatives.[74] NEPA requires a "discussion of alternatives" that "must '[r]igorously explore and objectively evaluate all reasonable alternatives.'"[75] The NRC's regulations implementing NEPA require that, FPL's "discussion of alternatives shall be sufficiently complete to aid the Commission in developing and exploring, pursuant to section 102(2)(E) of NEPA, 'appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources.'"[76] An agency's consideration of reasonable alternatives is "the heart" of NEPA.[77] "The existence of a viable but unexamined alternative renders [a NEPA document] inadequate."[78]

The Environmental Report considered only two alternatives: (1) the preferred alternative (renew the operating licenses for Units 3 and 4) and (2) the no-action alternative (not renew the operating licenses and, instead, implement replacement power sources).[79] The Environmental

(hereinafter "ER")..

[74] *See* 42 U.S.C. § 4332(2)(C).

[75] *Union Neighbors United, Inc. v. Jewell*, 831 F.3d 564, 569 (D.C. Cir. 2016) (quoting 40 C.F.R. § 1502.14).

[76] 10 C.F.R. § 51.45(b)(3).

[77] *Union Neighbors United,* 831 F.3d at 575 (citing 40 C.F.R. § 1502.14). CEQ's regulations implementing NEPA apply to all federal agencies, including the NRC. *Union Neighbors United*, 831 F.3d at 569 n.1 (citing 40 C.F.R. § 1500.3).

[78] *Natural Res. Defense Council v. U.S. Forest Serv.*, 421 F.3d 797, 813 (9th Cir. 2005) (internal quotation marks omitted); *see also City of Grapevine v. Dep't of Transp.*, 17 F.3d 1502, 1506 (D.C. Cir. 1994) (agency must consider "all 'feasible' or 'reasonable' alternatives[.]").

[79] ER, at 7-1.

Report evaluated three replacement power sources within the no-action alternative:

1. Natural Gas-Fired Generation. Construct a 1,726-MWe natural gas combined-cycle plant utilizing closed-cycle cooling with mechanical draft cooling towers using reclaimed water as the source of cooling water make-up.[80]

2. New Nuclear Generation. Construct a new nuclear facility with a 1,668-MWe generating capacity utilizing closed-cycle cooling with a mechanical draft cooling tower. Cooling water make-up would be reclaimed water from the Miami-Dade Water and Sewer Department.[81]

3. Combination of Natural Gas-Fired Generation and Solar PV Facilities. Construct a 1,636-MWe natural gas combined-cycle plant utilizing closed-cycle cooling with mechanical draft cooling towers. Construct four 75-MWe solar photovoltaic facilities (no cooling system required).[82]

In the license renewal context, NRC's NEPA regulations require all environmental reports to include certain analyses of environmental impacts of alternatives to the proposed action (granting a license renewal). 10 C.F.R. § 51.53(c)(iii) provides that the environmental report "must contain a consideration of alternatives for reducing adverse impacts, as required by § 51.45(c), for all Category 2 license renewal issues." 10 C.F.R. § 51.45(c) provides that the environmental report "must include an analysis that considers and balances the environmental effects of the proposed action, the environmental impacts of alternatives to the proposed action, and *alternatives available for reducing or avoiding adverse environmental effects*."[83]

The Environmental Report (§ 7.3) fails to satisfy either 10 C.F.R. §§ 51.45(c) or 51.53(c)(3)(iii). The ER purports to satisfy NEPA's obligation to consider alternatives available for reducing adverse impacts in two short, conclusory paragraphs devoid of any substantive

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[80] ER, at 7-3.
[81] ER, at 7-22.
[82] ER, at 7-4. *See also* ER, at 8-5, Table 8.0-2 (describing cooling system for each replacement power option).
[83] Emphasis added.

analysis. Section 7.3 of the Environmental Report (titled "Alternatives for Reducing Adverse Impacts") states:

> No additional alternatives were considered by FPL to reduce impacts, because . . . the continued operation of PTN does not result in significant adverse effects to the environment.[84]

The Environmental Report does not consider cooling towers as an alternative that would reduce adverse impacts related to the following Category 2 issues:

- Threatened, endangered, and protected species and essential fish habitat[85];
- Groundwater use conflicts (plants that withdraw more than 100 gallons per minute)[86]; and
- Radionuclides released to groundwater.[87]

Each of the above issues are Category 2 issues.[88]

a. *Replacing the existing cooling canal system with cooling towers is a reasonable alternative to granting the subsequent license renewal application.*

Replacing the existing cooling canal system with cooling towers is a reasonable and feasible alternative to granting the requested license renewal based on continued operation of the cooling canal system during the renewal term.[89] FPL itself has demonstrated that the siting and

[84] ER, at 7-39.
[85] ER, at 4-37 to 4-43.
[86] ER, at 4-22 to 4-23.
[87] ER, at 4-25 to 4-29.
[88] *See* Appendix B to Subpart A of Part 51–Environmental Effect of Renewing the Operating License of a Nuclear Power Plant, 10 CFR Pt. 51, Subpt. A, App. B.
[89] Declaration of Bill Powers (attached to Petition to Intervene by Southern Alliance for Clean Energy), submitted Aug. 1, 2018; *see generally* Expert Report of Bill Powers, P.E., Powers Engineering (hereinafter "Cooling Tower Feasibility Assessment") (Attachment K).

water supply aspects of cooling towers are feasible.

First, FPL chose cooling towers rather than the existing cooling canal system or another cooling system at Turkey Point Units 6 and 7, for which the NRC has granted combined construction permits and operating licenses. Both Units 6 and 7 would utilize closed-cycle wet-cooling towers using reclaimed water from the Miami-Dade Water and Sewer Department.[90] The EIS for Units 6 and 7 includes specific design elements of the cooling system, including: (a) a plan for piping reclaimed water from the Miami-Dade Water and Sewer Department South District Wastewater Treatment Plant to the cooling system for Units 6 and 7; (b) location of the water-treatment facility and related infrastructure; (c) storage of treated reclaimed water in a make-up water reservoir.[91]

Second, each of the three replacement power options under the no-action alternative considered in the Environmental Report incorporate closed-cycle cooling with mechanical draft cooling towers.[92] None of the replacement power options—not even the new nuclear generation option—would utilize the existing cooling canal system. In other words, under the alternative to shut down Units 3 and 4 and construct and operate a new nuclear plant, FPL has deemed construction of cooling towers as the best option, rather than utilization of the already

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[90] NRC Final Report, "Environmental Impact Statement for Combined Licenses for Turkey Point Nuclear Plant Units 6 and 7," ADAMS Accession No. ML16300A104 (Oct. 2016), at 3-8 to 3-14, *available at* https://www.nrc.gov/reactors/new-reactors/col/turkey-point/documents.html#eis (hereinafter "FEIS for Units 6 and 7"); Cooling Tower Feasibility Assessment, at 9-11.
[91] *Id.*
[92] ER, at 7-3, 7-22, 8-5.

constructed cooling canal system.

Third, Turkey Point Unit 5 (a natural gas combined-cycle unit that began operating in 2007) already utilizes mechanical-draft cooling towers that use make-up water drawn from the Upper Floridan Aquifer.[93] Thus, it is clear that the siting and water supply aspects of cooling towers are feasible.

Construction of cooling towers to replace the existing cooling canal system at Units 3 and 4 is feasible. Palisades Nuclear Plant, an 800-MW plant in Michigan, converted from a once-through cooling system to a closed-cycle wet cooling tower system after a significant period of operating utilizing the once-through system.[94] At least five other power plants have also converted to a closed-cycle system.[95]

The cost of replacing the cooling canal system with cooling towers is reasonable. The cost of the Palisades retrofit was approximately $99/kW in 2017 dollars.[96] The installed cost of cooling towers at Turkey Point Units 3 and 4, each of which has nearly the same capacity as Palisades (816 MW), would be approximately $81 million per unit for conventional inline mechanical draft cooling towers, or $162 million for both units.[97] This $160 million capital expense, amortized over only ten years at standard rates, equates to approximately $41 million

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[93] Cooling Tower Feasibility Assessment, at 7–8.
[94] EPA, "Technical Development Document for the Proposed Section 316(b) Phase II Existing Facilities Rule" (Apr. 2002), at 4-1 (hereinafter "EPA 2002 TDD").
[95] EPA 2002 TDD, at 4-1 to 4-6; Cooling Tower Feasibility Assessment, at 28–29 & n.138.
[96] Cooling Tower Feasibility Assessment, at 15.
[97] *Id*.

annual cost for both units.[98] Given that the subsequent license renewal periods, if granted, would not expire until 2052 and 2053, FPL could expect a much longer amortization period and, therefore, a lower annual cost. This would equate to an increase of less than one percent of the energy charge component of an FPL residential customer's bill.[99]

b. *Replacing the cooling canal system with cooling towers would satisfy the proposed action's purpose and need.*

NEPA requires the agency (or here, FPL) to "discuss those alternatives that are reasonable and 'will bring about the ends' of the proposed action."[100] The Environmental Report here considered only two alternatives: (1) the proposed action (renew the operating licenses for Units 3 and 4) and (2) the no-action alternative (not renew the operating licenses and, instead, implement replacement power sources).[101] FPL determined that those two alternatives constituted a reasonable range of alternatives because the proposed action "is to renew the [operating licenses] for PTN, which would preserve the option for FPL to continue to operate PTN and provide reliable base-load power throughout the 20-year SLR period to meet future power generating needs."[102]

But the proposed action's purpose and need—to continue to provide baseload power—does not limit the range of reasonable alternatives to (1) grant the license renewal application as

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[98] *Id.* at 15–16.
[99] *Id*. at 16.
[100] *In Re Hydro Res., Inc.*, 53 N.R.C. 31, 55 (Jan. 31, 2001) (quoting *Citizens Against Burlington v. Busey*, 938 F.2d 190, 195 (D.C. Cir. 1991)); *see also In the Matter of NextEra Energy Seabrook, LLC* (Seabrook Station, Unit 1), 75 N.R.C. 301, 342–43 (Mar. 8, 2012).
[101] ER, at 7-1.
[102] ER, at 7-1.

filed or (2) deny the application.[103] Instead, NEPA requires FPL to consider any reasonable alternative that satisfies the project's purpose and need. Construction of cooling towers satisfies that test. For the reasons described above, retrofitting the plant to use cooling towers is technically and economically feasible. And installing cooling towers aligns with the proposed action's purpose and need by allowing Units 3 and 4 to continue to provide baseload power.

c. *Replacing the existing cooling canal system with cooling towers would reduce adverse impacts related to Category 2 issues.*

i. <u>Threatened, endangered, and protected species and essential fish habitat</u>

Continued operation of Units 3 and 4 during the subsequent license renewal term will result in harm to threatened, endangered, and protected species and essential fish habitat. Replacing the cooling canal system with cooling towers would reduce these adverse impacts. Subsequent to the uprate for Units 3 and 4, both temperature and salinity in the cooling canal have increased, resulting in decreased nesting and fewer American crocodiles, an endangered species, observed in the cooling canals.[104] In 2017, the FWS explained that:

> [T]here has been a reduction in the number of crocodile nests produced within the CCS. A total of 9 nests were observed in 2015 and 8 in 2016. The decrease in nesting in the CCS has occurred with a concomitant decrease in the number of crocodiles observed within the CCS…. In addition, the body condition of many of the crocodiles observed within the CCS has decreased (i.e., animals appear emaciated and much thinner than healthy animals of the same total length).

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[103] *See* ER, at 1-1 (quoting NRC, "Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants," NUREG-1437, Vols. 1 & 3, Rev. 1 (June 2013) (discussing purpose and need) (hereinafter "2013 GEIS Revision").

[104] *See* Biological Opinion for Combined License for Turkey Point Nuclear Plant, Units 6 and 7 (June 23, 2017), at 20, (hereinafter "2017 BiOp"); *see infra* Contention 5-E.

> Moreover, anecdotal evidence suggests that a majority of the fish and invertebrate species that used to provide prey for the crocodile in the waters of the CCS no longer occur or are greatly diminished in numbers… [These issues] are thought to be the result of the recent increase in water temperature and salinity, and decrease in water quality within the waters of CCS observed during the past few years, beginning in 2013… [The cause for the decrease in water quality conditions] include FPL's recent increase in power production from nuclear Units 3 and 4, [and] the discharge of vegetative cutting within the CCS.[105]

Thus, ceasing operation of the cooling canals as a heat sink and replacing them with cooling towers, while keeping the canals in place, would protect existing American crocodile habitat. With an adequate effort to freshen the canals,[106] and without the dangerously high temperatures of the recent past, the canals would continue to provide valuable critical habitat into the future.

Furthermore, the cooling canal system has driven the westward migration of a hypersaline plume, resulting in salination of freshwater wetlands that are habitat for a range threatened and endangered species, including the Florida panther, American crocodile, indigo snake, snail kite, red knot and wood stork.[107] Replacing the cooling canals with cooling towers would mitigate serious environmental impacts on threatened and endangered species.[108]

ii. Groundwater use conflicts

The Environmental Report recognizes that "[i]f the applicant's plant pumps more than 100 gallons (total onsite) of groundwater per minute, an assessment of the impact of the

[105] 2017 BiOp, at 20.
[106] Direct Testimony and Exhibits of Sorab Panday, Docket No. 20170007-EI (Aug. 23, 2017), at 35:7-14 (Attachment L) (hereinafter "Panday Tr.")
[107] 2017 BiOp, at 44.
[108] *See infra* Contention 5-E.

proposed action on groundwater must be provided."[109] The ER acknowledges that continued use of the cooling canal system will further stress the already strained groundwater resources below and near Turkey Point.[110] Given these impacts on groundwater use conflicts (a category 2 issue) and the ability of cooling towers to reduce these impacts, construction of cooling towers is a reasonable alternative.

Both state and local governments have found FPL to be violating the water quality laws and regulations that they enforce by contaminating the freshwater portions of the Biscayne Aquifer. As a result, the Applicant has been ordered, through a series of administrative enforcement efforts by the Florida Department of Environmental Protection (FDEP) and Miami-Dade County, to take remedial measures, including adding 15 MGD of mildly saline water from the Floridan Aquifer (2.5 PSU) into the cooling canals to dilute canal salinities. FPL's goal is to achieve an average concentration of 34 PSU in the canals by April 2020.

The Applicant has now proposed and begun testing a plan to construct a "recovery well system" to attempt to draw the plume back toward the cooling canal system.[111] This plan would require installation of a series of wells located near the interceptor ditch and screened near the base of the Biscayne Aquifer that would withdraw approximately 14 MGD of water from that part of the aquifer for disposal via reinjection into the Boulder Formation.[112] The recovery well

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[109] ER, at 4-23.
[110] *See* ER, at 9-11 (noting notice of violation issued by the Florida Department of Environmental Protection related to the hypersaline plume migrating away from the cooling canal system toward the Biscayne Aquifer).
[111] ER, at 3-109.
[112] ER, at 3-109, 9-12 – 9-13.

system would assert additional pressure on existing groundwater use conflicts by withdrawing even more groundwater from an already stressed Biscayne Aquifer. The plan, moreover, would not abate continued leaching of hypersaline water from the unlined canals in the cooling canal system into groundwater.[113]

Recent developments suggest the remedial measures FPL is taking to mitigate the adverse environmental impacts of operating the cooling canal system measures are not having the intended effects.[114] Even if they do work as designed, there will still be net addition of salt to the aquifer from cooling canal system, and 15 MGD of saline water (34 PSU) migrating into aquifer every day, with part of that migrating into freshwater at upper levels of the aquifer causing adverse environmental impacts (impacts to freshwater wetlands and other surface waters, and impacts to listed species that rely on those wetlands, and salination of a potable water aquifer). These impacts reduce the amount of groundwater available to users in South Florida, including the Florida Keys, thereby exacerbating groundwater use conflicts.

Neither the NRC nor the Applicant has considered any other alternatives to mitigate these impacts on groundwater use conflicts. Because the stress on groundwater resources originates from operation of the cooling canal system as the ultimate heat sink for Units 3 and 4, the ER should have considered closure of the cooling canal system and installation of mechanical draft

[113] Panday Tr., at 35:7-36:12

[114] For example, recent salinity measurements in the L-31 canal west of the interceptor ditch indicate that saline water from the plume has surfaced in and entered the L-31 canal, from which it can now enter adjacent freshwater wetlands, causing further adverse environmental impacts. As the County explains, "The water quality of the L-31 E was initially freshwater and salinities during the period of record have increased to over 29 PSU." Letter from Lee N. Heft, Director, Miami-Dade County Division of Environmental Resources Management to Lee Crandall and Timothy Rach, Florid Department of Environmental Protection (July 18, 2018), at 3 (Attachment M) (hereinafter "FDEP-DERM July 2018 Letter"). Over the past ten years, canal salinities have trended upward and the highest salinities (29 PSU) were recorded during the first quarter of 2018. DERM-FDEP July 2018 Letter, at 55, 56.

cooling towers instead. The cooling tower alternative is certain to remediate the impacts of continued operation. Under such an alternative, there would be no new addition of salt to the aquifer.

Decommissioning the cooling canal system and construction of cooling towers would result in no future risk to groundwater use. Proper implementation of a closed-cycle cooling system would ensure no further harm to groundwater. FPL's failure to consider a cooling-tower alternative violates the requirement to consider alternatives that would reduce adverse impacts for all Category 2 license renewal issues.[115]

The Applicant's failure to consider cooling towers as an alternative is even more egregious when considered in light of new and significant information regarding the impacts of the cooling canal system on groundwater use conflicts. The agency (or here, FPL) is required to follow the "rule of reason" in preparing a NEPA document, and this rule "governs . . . *which* alternatives the agency must discuss."[116] The rule of reason does not permit the Applicant to delineate the range of alternatives in a vacuum. Instead, "where changed circumstances affect the factors relevant to the development and evaluation of alternatives, the [agency] must account for such change in the alternatives it considers."[117] "[T]he concept of 'alternatives' is an evolving one, requiring the agency to explore more or fewer alternatives as they become better

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[115] 10 C.F.R. §§ 51.53(c)(3)(iii) and 51.45(c).
[116] *Citizens Against Burlington, Inc. v. Busey*, 938 F.2d 190, 195 (D.C. Cir. 1991) (internal quotation marks omitted).
[117] *Natural Res. Defense Council v. U.S. Forest Serv.*, 421 F.3d 797, 813 (9th Cir. 2005).

known and understood."[118]

Rather than assessing this information and utilizing it to determine which alternatives to address and the extent to address them (as NEPA requires),[119] the Applicant relies on the naked assertion that the continued operation of Units 3 and 4—and, therefore, the cooling canal system —"does not result in significant adverse effects to the environment."[120] By any measure, this statement is false.[121] It is clear that continued operation of Units 3 and 4 will result in significant environmental effects relating to Category 2 issues. The Applicant should have considered new information regarding groundwater use impacts in delineating the range of alternatives.

iii. Radionuclides released to groundwater

Recent water sampling has found elevated tritium levels surrounding the cooling canal system.[122] Tritium is a radioactive type of hydrogen that is released with nuclear power plant wastewater.[123] The Applicant has documented nine releases of radioactive liquids into the environment.[124] As sea level rises and the cooling canal system is subject to more frequent inundation, the elevated levels of tritium found in the cooling canal system wastewater will spread into the environment. Conversion to a closed-cycle cooling system, such as cooling

[118] *Vermont Yankee Nuclear Power Corp. v. Nat. Res. Def. Council, Inc.*, 435 U.S. 519, 552–53 (1978).
[119] *See Natural Res. Defense Council*, 421 F.3d at 813.
[120] ER, at 7-39.
[121] An environmental impact statement will be prepared to analyze the environmental effects of the license renewal. 10 C.F.R. § 51.20(b)(2). An environmental impact statement is prepared only for "major federal actions *significantly* affecting the quality of the human environment." 42 U.S.C. 4332(2)(C) (emphasis added). The Applicant's statement in the Environmental Report that continued operation of Units 3 and 4 does not result in significant adverse environmental impacts is, therefore, contrary to the NRC's assessment, as well as the plain facts.
[122] Miami Herald, *FPL Nuclear Plant Canals Leaking Into Biscayne Bay, Study Confirms* (Updated May, 17, 2016), https://www.miamiherald.com/news/local/environment/article64667452.html.
[123] NRC, "Backgrounder on Tritium, Radiation Protection Limits, and Drinking Water Standards," https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/tritium-radiation-fs.html.
[124] ER, at 4-26.

towers, would eliminate discharges of wastewater into the environment and, thus, eliminate risk of further release of tritium into the environment. The Applicant's failure to consider such an alternative violates 10 C.F.R. §§ 51.53(c)(3)(iii) and 51.45(c).

d. *Applicant's failure to discuss the reasons for eliminating a cooling-towers alternative from further study violates NEPA.*

The Applicant's failure to even state the reasons it did not evaluate cooling towers as alternative violates NEPA. NEPA requires an agency (or here, FPL) to "[r]igorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from the detailed study, briefly discuss the reasons for their having been eliminated."[125] The Applicant made no attempt in the Environmental Report to comply with this requirement. Instead, the company summarily concluded that, because the purpose of the proposed action was to continue to provide baseload power during the subsequent renewal term, the alternatives that required consideration were the preferred alternative (granting the subsequent license renewal application) and the no-action alternative (denying the application). That does not satisfy NEPA's "hard look" test.

4. The issue raised in the contention is within the scope of the proceeding (10 C.F.R. § 203.9(f)(1)(iii))

NRC regulations broadly divide the scope of a license renewal proceeding into (1) safety/aging management issues, and (2) environmental impacts. This contention concerns environmental impacts. The scope of the required environmental review is established by 10 C.F.R. Part 51 and the GEIS for license renewals.[126] This contention is within the scope of the

[125] 40 C.F.R. § 1502.14(a).
[126] *Entergy Nuclear Vermont Yankee, LLC* (Vermont Yankee), LBP-06-20, 64 N.R.C. 131, 148-49 (2006).

proceeding because it challenges the sufficiency of the environmental analysis in the Environmental Report and the GEIS.

5. **The issue raised in the contention is material to the findings the NRC must make to support relicensing (10 C.F.R. § 203.9(f)(1)(iv))**

An issue is "material" if "the resolution of the dispute would make a difference in the outcome of the licensing proceeding."[127] "This means that there must be some link between the claimed error or omission regarding the proposed licensing action and the NRC's role in protecting public health and safety or the environment."[128] The issue raised in this contention—The Applicant's failure to comply with NRC's regulations requiring consideration of alternatives—relates directly to the NRC's role in protecting public health and safety and the environment. NEPA imposes requirements on the NRC to ensure environmental protection. The failure to comply with these requirements is material to the findings NRC must make to support relicensing. Petitioners request a hearing and intervention to present evidence that mechanical draft cooling towers are an alternative to mitigate adverse impacts of continuing to operate Units 3 and 4.

<u>CONTENTION 2-E:</u> THE ENVIRONMENTAL REPORT FAILS TO ADEQUATELY CONSIDER THE CUMULATIVE IMPACTS OF CONTINUED OPERATION OF UNITS 3 AND 4.

1. **Statement of the issue of law or fact to be raised or controverted (10 C.F.R. § 2.309(f)(1)(i))**

Applicant's Environmental Report (§ 4.12) fails to comply with 10 C.F.R.

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[127] *Vermont Yankee*, 64 N.R.C. at 149.
[128] *Id.*

§ 51.53(c)(3)(ii) because it does not address the "impacts of operation during the renewal term[] for those issues identified as Category 2 issues." Specifically, Applicant fails to adequately address cumulative impacts of the continued operation of Units 3 and 4 on water resources associated with reasonably foreseeable increases in sea levels rise and air temperature.[129] Applicant fails to address cumulative impacts on groundwater associated with its cooling canal system.[130]

2. Brief explanation of the basis for the contention (10 C.F.R. § 2.309(f)(1)(ii))

NRC's NEPA regulations require an applicant to include in its environmental report "analyses of the environmental impacts . . . associated with license renewal and the impacts of operation during the renewal term, for those issues identified as Category 2 issues in Appendix B to Subpart A of [Title 10, Part 51]."[131] These regulations specifically require an applicant to "provide information about other past, present, and reasonably foreseeable future actions occurring in the vicinity of the nuclear plant that may result in a cumulative effect."[132] This cumulative impacts analysis must account for climate change, including rising sea levels and a hotter climate.[133] A failure to take a hard look at cumulative impacts, including those from climate change, violates the NRC's NEPA regulations and thus NEPA.

Here, the Environmental Report does not address cumulative impacts from the reasonably foreseeable effects of climate change, including sea level rise and hotter temperatures.[134]

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[129] *See* 10 CFR Pt. 51, Subpt. A, App. B.
[130] *See* ER, at 4-68 – 4-69.
[131] 10 C.F.R. § 51.53(c)(3)(ii).
[132] 10 C.F.R. § 51.53(c)(3)(O).
[133] *See* 2013 GEIS Revision, at 1-30 (noting that climate change impacts on affected resources will be treated on a plant-specific basis).
[134] ER at 4-62 – 4-74.

While NRC Guidance provides that an applicant's cumulative impacts analysis may, under limited circumstances, assume cumulative impacts are avoided through management, those circumstances are not present here. Specifically, NRC Guidance allows an applicant to assume cumulative impacts regulated and monitored by a permitting process are managed if, but only if, the facility is "in compliance with their respective permits."[135] The Guidance does not authorize applicants to assume cumulative impacts are managed following permit violations.

Here, Applicant's Environmental Report fails to address cumulative impacts on groundwater because it assumes such impacts associated with the hypersaline plume from the cooling canal system "would be managed" based on compliance with a Consent Order with the Florida Department of Environmental Protection and a Consent Agreement with Miami-Dade County.[136] NRC Guidance, however, does not authorize Applicant to assume cumulative impacts will be managed where, as here, the applicant actually *violated* its permit and is now required to mitigate future violations and remediate existing impacts to correct its violations.[137]

3. The issue raised in the contention is within the scope of the proceeding (10 C.F.R. § 2.309(f)(1)(iii))

The issue is within the scope of the proceeding because NRC's NEPA regulations require

[135] NRC Regulatory Guide 4.2, Rev. 1, Supp. 1, "Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications," (July 2009), at 49, *available at* https://www.nrc.gov/docs/ML1306/ML13067A354.pdf.

[136] ER, at 4-68.

[137] *See e.g.*, *State of Florida Dep't of Environmental Protection v. Florida Power & Light Co.,* OGC File No. 16-0241 (Fla. Dep. of Envt'l Prot. Jun. 20, 2016) (Consent Order), ¶ 19 (Ordering Applicant to "cease discharges from the [cooling canal system] that impair the reasonable and beneficial use of the adjacent G-II ground waters to the west of the [cooling canal system] in violation of Condition IV.1 of the Permit and Rule 62-520.400, F.A.C.").

a plant-specific assessment of cumulative impacts in the applicant's Environmental Report.[138] Additionally, the NRC recognizes that "impacts from individually minor actions may be significant when considered collectively over time."[139]

4. The issue raised in the contention is material to the findings the NRC must make to support the action that is involved in the proceeding (10 C.F.R. § 2.309(f)(1)(iv))

The issue raised is material to the findings NRC must make because the NRC is required to undertake a cumulative impacts analysis.[140] The issue is also material because a failure to take a hard look at cumulative impacts associated with the proposed project constitutes a violation of NEPA.

5. Concise statement of the alleged facts or expert opinions which support the petitioner's position on the issue and on which the petitioner intends to rely at hearing (10 C.F.R. § 2.309(f)(1)(v))

Global mean sea level in the area around Turkey Point has risen over the past century and is projected to continue rising at an accelerated rate throughout this century and beyond.[141] Relative to the year 2000, there is at least a 90 percent probability that global mean sea level will rise by 0.3–0.6 feet by 2030 and 0.5–1.2 feet by 2050.[142] By 2100, scientists predict that global mean sea level will rise by at least 1.0 foot and could rise more than 8 feet under certain

[138] Appendix B to Subpart A of Part 51–Environmental Effect of Renewing the Operating License of a Nuclear Power Plant, 10 CFR Pt. 51, Subpt. A, App. B
[139] ER, page 4-63 (referencing 2013 GEIS Revision, § 4.13).
[140] 10 CFR Pt. 51, Subpt. A, App. B
[141] Declaration of Dr. Robert Kopp ("Kopp Decl.") ¶ 12(i) (Attachment N) (referencing William V. Sweet et al., "*Sea Level Rise*," in CLIMATE SCIENCE SPECIAL REPORT: FOURTH NATIONAL CLIMATE ASSESSMENT, VOL. 1 333–363 (D.J. Wuebbles et al. eds., 2017).
[142] *Id.* ¶ 12(ii).

greenhouse gas emissions and Antarctic ice sheet stability scenarios.[143] Sea-level rise for the remainder of this century in south Florida, including around Turkey Point will be faster than the average over the last century in every reasonably foreseeable climate change scenario.[144]

Through 2060, there is between a 68 and 95 percent chance that average sea-level rise at the Key West tidal gauge, which reflects relative sea level at Turkey Point, will exceed 1 foot above the National Tidal Datum Epoch.[145] Through 2060, there is a 10 to 37 percent chance that average sea level rise will exceed 2 feet if today's rate of growth in emissions of greenhouse gases continues, leading to a near-doubling of carbon dioxide emissions between today and 2050, with continued growth thereafter.[146] By 2100, there is a 15 to 83 percent chance that average sea level will exceed 4 feet if today's rate of growth in emissions of greenhouse gases continues.[147]

Most experts believe hurricanes and tropical storms will become more intense as temperatures rise due to climate change.[148] Assuming storm characteristics do not change, sea level rise will increase the frequency and extent of extreme flooding associated with coastal storms, such as hurricanes.[149] For an intense storm with an appropriate track, extreme water levels well above the highest level observed historically at a particular site are well within the

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[143] *Id*. ¶ 12(ii),
[144] *Id*. ¶ 13.
[145] *Id*. ¶¶ 17, 30(a).
[146] *Id*. ¶¶ 25, 30(b).
[147] *Id*. ¶ 30(c).
[148] *Id*. ¶ 15.
[149] *Id*. ¶ 12(v).

range of possibility. [150]

The effect of sea level rise can be added to storm surge. Extreme high-water levels arise from the superimposition of tidal and storm influences on top of average sea level.[151] If the sea level rises by one foot, for example, the probability of storms increasing water levels to the height of 2.0 feet becomes 50% rather than 1%.[152] Even with drastic reductions in emissions of greenhouse gases and with a relatively stable Antarctic ice sheet, it is likely (greater than two chances in three) that sea-level rise will exceed 1 foot in south Florida by 2060.[153] If the Antarctic becomes unstable, as predicted by some, and greenhouse gas emissions continue to grow at today's rate, sea level rise in Florida is likely to exceed 4 feet by 2100, and there is a greater than 1-in-10 chance of exceeding 10 feet by 2100.[154] The annual average temperature of the contiguous United States is projected to rise throughout this century.[155] For the period 2021–2050, temperatures are projected to rise on average by 2.5°F for a lower scenario, which still makes this near-term average comparable to the hottest year in the historical record (2012).[156] Projected temperature increases in the Southeast for the 2036–2065 period range from 3.40°F to 4.30°F.[157] Projected changes in temperatures extremes for the Southeast region over 2036–2065

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[150] *Id.* ¶ 33.
[151] *Id.* ¶ 31.
[152] *Id.* ¶ 34.
[153] *Id.* ¶ 38.
[154] *Id.* ¶ 40.
[155] CLIMATE SCIENCE SPECIAL REPORT, at 195.
[156] *Id.*
[157] *Id.* at 197, Table 6.4.

are projected to be 5.79°F for the warmest day of the year compared to the 1976–2005 period.[158] Change in the warmest 5-day, 1-in-10-year event for the same period is 11.09°F.[159] Extreme temperatures in the contiguous United States are projected to increase even more than average temperatures, with heat waves becoming more intense.[160]

The Applicant's current operating license limits allowable intake water temperature for Units 3 and 4 at 104°F.[161] In 2014 The Applicant requested and received from the NRC a modification to its license authorizing an increase of 4°F (from 100 to 104) for its cooling water intake.[162] FPL requested this modification to its license because "prolonged hot weather in the area has resulted in sustained elevated [Ultimate Heat Sink] temperatures . . . . High temperatures during the daytime with little cloud cover and low precipitation have resulted in elevated canal water temperatures at the Turkey Point site."[163] The average intake temperature of cooling water for Units 3 and 4 is 2.5°F above the average ambient air temperature.[164] The foreseeable increase in air temperature at Turkey Point during the subsequent license renewal period, absent mitigating measures, will cause intake water temperatures to exceed the 104°F limit in Applicant's operating license. An increase in air temperature during the subsequent license renewal period will increase the rate of evaporation from the cooling water canals,

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[158] *Id*. at 198, Table 6.5.
[159] *Id*.
[160] *Id*. at 202.
[161] ER, at 3-112.
[162] ER, at 3-112.
[163] FP&L, Letter, "Request for Enforcement Discretion Regarding Technical Specification 3/4.7.4, Ultimate Heat Sink," ADAMS Accession No. ML14204A083 (July 21, 2014), encl. at 3.
[164] FP&L, Letter, "License Amendment Request No. 231, Application to Revise Technical Specification to Revise Ultimate Heat Sink Temperature Limit," ADAMS Accession No. ML14196A006 (July 10, 2014), encl. at 5.

thereby increasing salinity in the canals and cumulative impacts on groundwater. Additional mitigation measures or alternatives will be necessary to lower this increase in salinity.

6. A genuine dispute exists with the applicant on a material issue of law or fact (10 C.F.R. § 2.309(f)(1)(vi))

A genuine dispute exists with the Applicant's analysis of cumulative impacts on water resources. First, Applicant failed to consider cumulative impacts on water resources associated with reasonably foreseeable increases in sea level rise and hotter temperatures during the subsequent license renewal period. Second, Applicant erroneously assumes that cumulative impacts associated with the hypersaline plume emanating from the cooling canal system will be mitigated through a management program. NRC guidance, however, authorizes an applicant to make this assumption only when it complies with its permits. Here, Applicant *violated* its permits and has caused significant impacts on groundwater resources in the vicinity of Turkey Point.

a. *Section 4.12.4 Fails to Analyze Cumulative Impacts on Water Resources*

Applicant's approach to analyzing the cumulative impacts on water resources from climate change is woefully inadequate. The Environmental Report omits sea level rise from the list of "climate change indicators" when sea level rise will significantly impact Turkey Point.[165] Indeed, the reasonably foreseeable impacts from sea level rise during the current license renewal period have already required the company to implement mitigation measures to protect against flood events.[166] Applicant predicts a sea level rise of 0.39 feet *before* its current license expires

[165] ER, at 4-69 – 4-71.
[166] FP&L, Letter, "NEI 12-06, Revision 2, Appendix G, G.4.2, Mitigating Strategies Assessment (MSA) for FLEX Strategies report for the New Flood Hazard Information," ADAMS Accession No. ML17012A065 (Dec. 20, 2016).

in the early 2030s. Applicant cannot meaningfully address cumulative impacts from climate change without accounting for greater and more accelerated sea level rise during the subsequent license renewal period.

Applicant describes its cooling canal system as a "closed-cycle" system with no apparent "discernable influence on Biscayne Bay." However, reasonably foreseeable impacts from sea level rise will increase the risk of flooding at Turkey Point, including the potential for overtopping or breach of the canal system, leading to direct discharges of polluted canal water into surface water resources including Biscayne Bay.

Applicant also fails to analyze cumulative impacts on water resources associated with the reasonably foreseeable increase in air temperature. Higher air temperatures will increase the rate of evaporation in the cooling canal system leading to more saline conditions. Higher salinity in the cooling canals will, as has been shown, adversely impact groundwater resources.

b. *Applicant's Environmental Report (§ 4.12.4.2) Erroneously Assumes that Cumulative Impacts Associated with its Hypersaline Plume will be Managed.*

As a matter of law, Applicant may not rely on NRC Regulatory Guide 4.2, Revision 1 to assume that cumulative impacts from its plant will be eliminated through a management program.[167] The Guidance provides that applicants for a license renewal may assume cumulative impacts are managed under certain limited circumstances. For an applicant to benefit from this assumption, the cumulative impacts must be regulated and monitored by a permitting process and the facility must be "in compliance with their respective permits."[168]

[167] ER, at 4-86.
[168] NRC Regulatory Guidance 4.2, Rev. 1, Supp. 1, at 49.

Here, however, Applicant violated its permits and relevant regulations with respect to groundwater resources. For example, discharges from the cooling canal system have impaired "the reasonable and beneficial use of adjacent G-II ground waters to the west of the [Cooling Canal System] in violation of Condition IV.1 of [Applicant's] Permit and Rule 62-520.400, F.A.C."[169] Applicant seeks to turn the NRC guidance on its head by conflating permit compliance with remedial compliance. These are not the same. The former represents continual compliance with applicable permit conditions and regulations. The latter represents actual harm to the environment with new conditions and requirements, arrived through negotiations, seeking to correct past harm to the environment and mitigate future harm. NRC's NEPA regulations and guidance do not authorize Applicant to assume cumulative impacts will be managed when the facts demonstrate that impacts have not been managed through permit compliance.

<u>CONTENTION 3-E</u>: THE ENVIRONMENTAL REPORT FAILS TO CONSIDER NEW AND SIGNIFICANT INFORMATION REGARDING THE EFFECT OF SEA LEVEL ON CERTAIN CATEGORY 1 AND 2 ISSUES, IN VIOLATION OF 10 C.F.R. § 51.53(C)(3)(iv).

1. Statement of the issue of law or fact to be raised or controverted (10 C.F.R. § 2.309(f)(1)(i))

The Environmental Report (§§ 3 and 5) fails to comply with 10 C.F.R. § 51.53(c)(3)(iv) because it fails to analyze new and significant information regarding the effect of sea level rise on a number of Category 1 and 2 issues. Section 51.53(c)(3)(iv) requires an environmental

[169] *State of Florida Dep't of Environmental Protection v. Florida Power & Light Co*., OGC File No. 16-0241 (Fla. Dep. of Envt'l Prot. Jun. 20, 2016) (Consent Order) ¶ 19.

report submitted as part of a license renewal application to "contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware." Neither the GEIS nor the Environmental Report contains any analysis of new and significant information regarding sea level rise relating to the following Category 1 or 2 issues:

- Surface water use conflicts (Category 2)
- Groundwater use conflicts (plants that withdraw more than 100 gallons per minute) (Category 2)
- Cumulative impacts (Category 2)
- Termination of plan operations and decommissioning (Category 1)

1. Brief explanation of the basis for the contention (10 C.F.R. § 2.309(f)(1)(ii)) and concise statement of the alleged facts or expert opinions supporting the contention (10 C.F.R. § 2.309(f)(1)(v))

NRC regulations require an environmental report to consider any "new and significant" information that may alter previous environmental conclusions.[170] "New and significant information" is defined as "[i]nformation not considered in the assessment of impacts evaluated in the GEIS leading to a seriously different picture of the environmental consequences of the action than previously considered."[171]

This obligation applies to both Category 1 and 2 issues.[172] "[E]ven where the GEIS has found that a particular impact applies generically (Category 1), the applicant must still provide

[170] 10 C.F.R. § 51.53(c)(3)(iv).
[171] ER, at 5-1 (citing NRC Regulatory Guide 4.2, Supp. 1, Rev. 1).
[172] *Massachusetts v. United States*, 522 F.3d 115, 120 (1st Cir. 2008).

additional analysis in its Environmental Report if new and significant information may bear on the applicability of the Category 1 finding at its particular plant."[173] This requirement is intended to ensure that "[w]hen the GEIS and SEIS are combined [or here, the GEIS and the Environmental Report], they cover all issues that NEPA requires be addressed in an EIS for a nuclear power plant license renewal proceeding."[174]

Here, the GEIS and the Environmental Report, when combined, do not "cover all issues that NEPA requires be addressed." Far from it: the GEIS expressly recognized that analysis of the effects of GHG emissions and climate change upon nuclear power plants could not be assessed generically.[175] The GEIS provided, therefore, that "each SEIS [will include] a plant-specific analysis of any impacts caused by GHG emissions over the course of the license renewal term *as well as any cumulative impacts caused by potential climate change upon the affected resources during the license renewal term*."[176]

The Environmental Report, however, fails to include an analysis of the effects of sea level rise in relation to numerous Category 1 and 2 issues. Beyond a brief mention that sea level rise will impact certain threatened, endangered, and sensitive species, the Environmental Report

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[173] *In the Matter of Fla. Power & Light Co*. (Turkey Point Nuclear Generating Plant, Units 3 & 4), 54 N.R.C. 3, 11 (July 19, 2001).
[174] *Massachusetts*, 522 F.3d at 120.
[175] 2013 GEIS Revision, at 1-29 to 1-30.
[176] 2013 GEIS Revision, at 1-30 (emphasis added); *see also In the Matter of Duke Energy Carolinas, LLC* (Combined License Application for William States Lee III Nuclear Station, Units 1 & 2), 84 N.R.C. 180 (Dec. 15, 2016); *In the Matter of Tennessee Valley Auth.* (Bellefonte Nuclear Power Plant, Units 3 & 4) 2009 WL 3659545, at *3 (N.R.C. Nov. 3, 2009) ("We expect the Staff to include consideration of carbon dioxide and other greenhouse gas emissions in its environmental reviews for major licensing actions under the National Environmental Policy Act.").

does not discuss sea level rise *at all*.[177] Section 5 of the Environmental Report, "Assessment of New and Significant Information," contains only a summary of the process used by FPL to assess whether any new and significant information required analysis. The entirety of the FPL's analysis appears in one sentence: "As a result of this review, FPL is aware of no new and significant information regarding the environmental impacts of license renewal associated with PTN." [178] That conclusion fails to address information relating to sea level rise. This information is both new and significant.

The failure to address sea level rise is even more stark in light of Applicant's acknowledgement of future sea level rise at Turkey Point. In 2016, the company acknowledged that probable maximum storm surge exceeded the plant's design basis in several respects when "20 Year Sea Rise" was considered.[179] In the same document, FPL acknowledged that three "flood barrier segments" at Turkey Point "are not sufficient" to prevent flooding "when the projected 20 year sea-level rise of 0.39 inches is included."[180]

Moreover, the Final Environmental Impact Statement prepared for issuance of the combined construction permits and operating licenses for Turkey Point Units 6 and 7

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[177] ER, at 3-181, 3-205, 3-210, 4-71.
[178] ER, at 5-4.
[179] FP&L, Letter, "NEI 12-06, Revision 2, Appendix G, G.4.2, Mitigating Strategies Assessment (MSA) for FLEX Strategies report for the New Flood Hazard Information," ADAMS Accession No. ML17012A065 (Dec. 20, 2016), encl. at 11, Table 2.2-3.
[180] *Id*. encl. at 16; *see also id.* ("In the longer term, sea level rise may result in wave run-up overtopping the north and south barriers in the turbine building."). Additionally, a projected 20-year sea level rise of 0.39 inches unreasonably low and not supported by any evidence. *See* Kopp Decl. at ¶ 30(a) and (d) (projecting a 68-95 percent chance that average sea level rise at Key West will exceed 1 foot by 2060 and, under a "High emissions scenario," projecting a 1.5-39 percent chance that average sea level rise will exceed 6 feet by 2100).

acknowledge that global sea level is projected to rise 1 to 4 feet by 2100, and that some projections predict 8.2 feet by 2100 relative to 2000.[181] The FEIS acknowledged that this scenario would mean that "much of South Florida would be uninhabitable and millions of people would likely be displaced."[182] The FEIS further acknowledged that:

- "Sea-level rise combined with more frequent Category 4 and 5 storms will increase the potential for damaging storm surge events at the Turkey Point site."[183]
- Sea level rise and storm surge would result in release of "sediment and nutrients" from the Turkey Point site.[184]
- "Sea-level rise could stress mangrove forests due to inundation and could stress surviving wetland vegetation by introducing brackish water farther inland," as well as also "place additional stress on the same habitats and wildlife affected by [Turkey Point's] operational impacts." [185]

Despite the above discussion of the effects of sea level rise in the Units 6 and 7 FEIS, the Environmental Report submitted with the Units 3 and 4 license renewal application fails to address the issue at all. This deficiency violates NEPA.

a. *Cumulative effects (Category 2)*

The Environmental Report's cumulative effects analysis (§ 4.12) fails entirely to discuss

[181] NRC, Final Report, "Environmental Impact Statement for Combined Licenses (COLs) for Turkey Point Nuclear Plant Units 6 and 7, Appendices A to K," ADAMS Accession No. ML16301A018 (Oct. 2016), App. I at I-3, *available at* https://www.nrc.gov/docs/ML1630/ML16301A018.pdf; *see also* Kopp Decl. at ¶¶ 38.
[182] *Id.*
[183] *Id.* at I-5.
[184] *Id.* at I-6
[185] *Id.* at I-6 to I-7. Because Units 6 and 7, if constructed, will be cooled by cooling towers rather than the existing cooling canal system, the FEIS for Units 6 and 7 did not address the effects of sea level rise in relation to the cooling canal system.

the sea level rise-related impacts upon affected resources. The GEIS recognized that "[c]hanges in climate have the potential to affect air and water resources, ecological resources, and human health, and should be taken into account when evaluating cumulative impacts over the license renewal term." [186] But the Environmental Report fails to address a primary localized effect of climate change: sea level rise. This failure violates the GEIS's assurance that each SEIS (or environmental report) will contain "a plant-specific analysis of any impacts caused by GHG emissions over the course of the license renewal term as well as any cumulative impacts caused by potential climate change upon the affected resources during the license renewal term."[187]

b. *Water resources (Surface water use conflicts (Category 2) and groundwater use conflicts (plants that withdraw more than 100 gallons per minute) (Category 2))*

The Environmental Report erroneously fails to account for the effect sea level rise will have on freshwater availability, ground water resources, and release of polluted cooling water into Biscayne Bay.[188] The Environmental Report's analysis of water resources impacts rests on the assumption that the cooling canal system is a "closed-loop" system and will not release of radionuclides or other pollution into the environment—an assumption that will no longer be valid once sea level rise has eliminated the "closed-loop" nature of the cooling canal system.[189]

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[186] 2013 GEIS Revision, at 1-29.
[187] 2013 GEIS Revision, at 1-30; *see* Contention 3-E.
[188] *See* ER, at 4-20 – 4-29.
[189] E.g., ER, at 4-26. The cooling canal system is not "closed-loop." *See* ER at 3-114 ("The cooling canals by design are in direct hydraulic connection to the underlying surficial aquifer and are authorized to discharge to groundwater by the state of Florida IWW permit and the associated federal NPDES permit which is issued under delegation to the state of Florida[.]").

Climate change will result in sea level rise and more extreme and more frequent storm surges at Turkey Point.[190] Sea level rise will result in a frequent interchange of water from Biscayne Bay and the cooling canal system. These effects paint a "seriously different picture of the environmental consequences of the action than previously considered," and therefore must be considered.[191]

c. *Termination of plant operations and decommissioning (Category 1)*

Neither (1) the license renewal GEIS, (2) the GEIS prepared to analyze impacts related to plant decommissioning, nor (3) the Environmental Report addresses the effects of sea level rise on termination of plant operations and the decommissioning process.[192] Sea level rise will affect Applicant's ability to terminate plant operations and decommission the plant. If a subsequent license renewal is granted, Units 3 and 4 operating licenses will expire in the early 2050s, and the decommissioning process is expected to take 60 years to complete. This means that decommissioning will continue well past 2100, when sea level at Turkey Point could rise between four and ten feet.[193] NEPA requires either a GEIS or the Environmental Report to analyze this issue.[194] The failure to do so violates NEPA.

2. The issue raised in the contention is within the scope of the proceeding because it relates to Applicant's failure to consider new and significant information relating to Category 1 and 2 issues (10 C.F.R. § 203.9(f)(1)(iii))

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[190] Kopp Decl. at ¶¶ 12(iv).
[191] ER, at 5-1.
[192] *See* 2013 GEIS Revision, at 4-10; NRC, Final Report, "Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, Vol. 1, Supp. 1 (NUREG-0586)," ADAMS Accession No. ML023500395 (Nov. 2002); ER, at 7-1.
[193] Kopp. Decl. at ¶¶ 40.
[194] *Massachusetts*, 522 F.3d at 120.

This issue is within the scope of the proceeding because NRC's NEPA regulations require the Environmental Report to include "any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware."[195]

3. The issue raised in the contention is material to the findings the NRC must make to support relicensing (10 C.F.R. § 203.9(f)(1)(iv))

An issue is "material" if "the resolution of the dispute would make a difference in the outcome of the licensing proceeding."[196] "This means that there must be some link between the claimed error or omission regarding the proposed licensing action and the NRC's role in protecting public health and safety or the environment."[197] The issue raised in this contention—Applicant's failure to comply with NRC's regulations requiring consideration of all relevant information in its NEPA analysis—relates directly to the NRC's role in protecting public health and safety and the environment. NEPA imposes requirements on the NRC to ensure environmental protection. The failure to comply with these requirements is material to the findings NRC must make to support relicensing.

4. A genuine dispute of material fact or law exists regarding the Environmental Report's analysis (10 C.F.R. § 2.309(f)(1)(vi))

A genuine dispute of material fact or law exists regarding the sufficiency of the ER's analysis of new and significant information. The Applicant has concluded that it need not

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[195] 10 C.F.R. § 51.53(c)(3)(iv).
[196] *Vermont Yankee*, 64 N.R.C. at 149.
[197] *Id.*

discuss any new and significant information regarding the environmental impacts of license renewal.[198] Petitioners contend to the contrary, that the ER's failure to analyze new and significant information regarding the effect of sea level rise on numerous category 1 and 2 issues is unlawful.[199]

CONTENTION 4-E: THE ENVIRONMENTAL REPORT FAILS TO DESCRIBE THE FORESEEABLE AFFECTED ENVIRONMENT DURING THE SUBSEQUENT LICENSE RENEWAL PERIOD.

1. Statement of the issue of law or fact to be raised or controverted (10 C.F.R. § 2.309(f)(1)(i))

Applicant's Environment Report (§ 3) erroneously fails to describe the reasonably foreseeable affected environment during the subsequent license renewal period (2032–2053) in violation of 10 C.F.R. § 51.53(c)(2). This failure renders Applicant's analyses of environmental impacts (§ 4), mitigating actions (§ 6), and alternatives analysis (§ 8) legally insufficient.[200]

2. Brief explanation of the basis for the contention (10 C.F.R. § 2.309(f)(1)(ii))

NEPA prohibits agencies from making decisions without first taking a "hard look" at the environmental consequences, requiring agencies to prepare an environmental impact statement (EIS).[201] The "heart" of the EIS is the agency's evaluation and analysis of alternatives to the proposed action.[202] This analysis turns on an accurate description of the areas "to be affected by

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[198] ER at 5-4.
[199] *See* 54 Fed. Reg. at 33,170 ("Where the intervenor believes the application and supporting material do not address a relevant matter, it will be sufficient for the intervenor to explain why the application is deficient.").
[200] 42 U.S.C. § 4332(2)(A); 10 C.F.R. § 51.53(c)(3)(ii) and (iii).
[201] *Sierra Club v. Fed. Energy Regulatory Comm'n*, 867 F.3d 1357, 1367 (D.C. Cir. 2017).
[202] 10 C.F.R. Part 51, App. A, §§ 4, 5; *see also* 40 C.F.R. § 1502.14.

the proposed action."[203] Without an accurate description of the affected environment, an agency is unable to meaningfully "understand the effects of the alternatives."[204]

When the impacts occur is as important as where.[205] A description of the affected environment as it exists today is legally insufficient when the environment will undergo reasonably foreseeable and significant changes by the time the project commences and throughout its proposed lifetime. An agency's failure to consider this information in any meaningful or logical way violates NEPA.[206]

Here, Applicant omitted from its Environmental Report any description of reasonably foreseeable and significant aspects of the affected environment. The Environmental Report fails to discuss the changes in the surrounding environment and their effects on Turkey Point, including sea level rise, increased air temperature, increased surface water temperature, acidification, annual precipitation, drought, and increased storm intensity.[207] Thus, the Applicant

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[203] 10 C.F.R. Part 51, App. A, § 6; *see also* 10 C.F.R. § 51.53(c)(2) (requiring a detailed description of the affected environment).

[204] 40 C.F.R. § 1502.15.

[205] 10 C.F.R. § 51.53(c)(3)(ii) (requiring analyses of "environmental impacts of the proposed action . . . *during the renewal term*.").

[206] *See AquAlliance v. U.S. Bureau of Reclamation*, 287 F. Supp. 3d 969, 1031–32 (E.D. Cal. 2018) (granting summary judgment to plaintiffs where agency failed to reconcile information on climate change impacts with ultimate conclusions about proposed action).

[207] Applicant admits elsewhere that sea level rise is reasonably foreseeable, relevant, and significant. *See e.g.* FP&L, Letter, "NEI 12-06, Revision 2, Appendix G, G.4.2, Mitigating Strategies Assessment (MSA) for FLEX Strategies report for the New Flood Hazard Information," ADAMS Accession No. ML17012A065 (Dec. 20, 2016), encl. at 16 (stating that various barrier segments at the plant are "adequate for the current sea-level; however, they are not sufficient when the projected 20 year sea-level rise of 0.39 inches is included and require modification to increase the height of the flood barrier."); *see also*, Attachment Q, Declaration of David Lochbaum, who provided an expert declaration upon which Petitioners rely and states: "[t]he license renewal rule, specifically 10 CFR 54.29, states that a renewed license may be issued if the Commission finds that "there is reasonable assurance that the activities authorized by the renewed license will continue to be conducted in accordance with the CLB" [current

provided no analysis of alternatives to avoid the effects of these changes. As a result, Applicant's Environmental Report violates 10 C.F.R. § 51.53(c)(2), 40 C.F.R. § 1202.15, and 42 U.S.C. § 4332(2)(C).

3. The issue raised in the contention is within the scope of the proceeding (10 C.F.R. § 2.309(f)(1)(iii))

NRC's NEPA regulations require an applicant for a license renewal to draft an Environmental Report.[208] The regulations specifically require a detailed description of the effected environment, which forms the basis of the applicant's, and later the NRC's, analyses of environmental impacts, mitigation measures, and alternatives.[209] Consequently, Applicant's failure to describe the affected environment during the relevant time frame is within the scope of this proceeding.

4. The issue raised in the contention is material to the findings the NRC must make to support the action involved in the proceeding (10 C.F.R. § 2.309(f)(1)(iv))

A contention is "material" to the NRC's duty to make environmental findings if the issue of law or fact it raises "is of possible significance to the result of the proceeding. This means that there should be some significant link between the claimed deficiency and either the health and safety of the public or the environment."[210]

The issue raised in this contention is material because Applicant's failure to describe the

licensing basis]. Because the flooding evaluations and assessments only went out to 2033, the expiration of the current operating licenses, and there is no evaluation or assessment concluding that reactor operation beyond 2033 will remain bound by those analyses, reasonable assurances needed to issue subsequent license renewals cannot be found." Att. Q at ¶ 41.

[208] 10 C.F.R. § 51.53(c).

[209] *Id*.

[210] *In re Entergy Nuclear Vt. Yankee L.L.C. & Entergy Nuclear Operations*, 60 N.R.C. 548, 556, 2004 NRC LEXIS 247, *16-17 (N.R.C. November 22, 2004).

reasonably foreseeable affected environment during the subsequent license renewal period taints the analyses of environmental impacts, mitigating actions, and alternatives. There are plainly real and significant differences, both in terms of safety and environmental impacts, between operating Units 3 and 4 in the affected environment described in Applicant's environmental report and one that is substantially hotter and prone to extreme flooding.

5. Concise statement of facts or expert opinions which support Petitioner's position and on which the Petitioner intends to rely at hearing (10 C.F.R. § 2.309(f)(1)(v))

Global mean sea level in the area around Turkey Point has risen over the past century and is projected to continue rising at an accelerated rate throughout this century and beyond.[211] Relative to the year 2000, there is at least a 90 percent probability that global mean sea level will rise by 0.3–0.6 feet by 2030 and 0.5–1.2 feet by 2050.[212] By 2100, scientists predict that global mean sea level will rise by at least 1.0 foot and could rise more than 8 feet under certain greenhouse gas emissions and Antarctic ice sheet stability scenarios.[213] Outside of Alaska, relative sea level rise along all U.S. coastlines will be greater than the global average rise.[214]

Sea-level rise for the remainder of this century in south Florida, including around Turkey Point will be faster than the average over the last century in every reasonably foreseeable climate change scenario.[215] Through 2060, there is between a 68 and 95 percent chance that average sea-

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[211] Kopp Decl. ¶ 12(i) (referencing William V. Sweet et al., *Sea Level Rise*, in CLIMATE SCIENCE SPECIAL REPORT: FOURTH NATIONAL CLIMATE ASSESSMENT, VOL. 1 333–363 (D.J. Wuebbles et al. eds., 2017).
[212] *Id*. ¶ 12(ii).
[213] *Id*. ¶¶ 12(ii), 40.
[214] *Id*. ¶ 12(iii).
[215] *Id*. ¶ 13.

level rise at the Key West tidal gauge, which reflects relative sea level at Turkey Point, will exceed 1 foot above the National Tidal Datum Epoch.[216] Through 2060, there is a 10 to 37 percent chance that average sea level will exceed 2 feet with continuing unchecked fossil-fuel-based economic growth, leading to a near-doubling of carbon dioxide emissions between today and 2050, with continued growth thereafter.[217] By 2100, there is a 15 to 83 percent chance that average sea level will exceed 4 feet if the world's use of fossil fuels continues to grow unabated.[218]

Assuming storm characteristics do not change, sea level rise will increase the frequency and extent of extreme flooding associated with coastal storms, such as hurricanes.[219] Extreme high-water levels arise from the superimposition of tidal and storm influences on top of average sea level.[220] Most experts believe hurricanes and tropical storms will become more intense as temperatures rise due to climate change.[221]

For an intense storm with an appropriate track, extreme water levels well above the highest level observed historically at a particular site are well within the range of possibility.[222] The effect of sea level rise can be added to storm surge. If the sea level rises by one foot, for example, the probability of storms increasing water levels to the height of 2.0 feet becomes 50%

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[216] *Id.* ¶¶ 30(a).
[217] *Id.* ¶¶ 25, 30(b).
[218] *Id.* ¶ 30(c).
[219] *Id.* ¶ 12(v).
[220] *Id.* ¶ 31.
[221] *Id.* ¶ 15.
[222] *Id.* ¶ 33.

rather than 1%.[223]

Even if emissions are drastically curtailed, and the Antarctic Ice Sheet remains relatively stable, it is likely (greater than two chances in three) that sea-level rise will exceed 1 foot in south Florida by 2060.[224] If emissions around the world continue to grow unrestrained, and the Antarctic Ice Sheet becomes unstable, sea-level rise in Florida is likely to exceed 4 feet by 2100, and there is a greater than 1-in-10 chance of exceeding 10 feet by 2100.[225]

The annual average temperature of the contiguous United States is projected to rise throughout this century.[226] For the period 2021–2050, temperatures are projected to rise on average by 2.5°F for a lower scenario, which still makes this near-term average comparable to the hottest year in the historical record (2012).[227] Projected temperature changes in the Southeast for the 2036–2065 period range from 3.40°F to 4.30°F.[228] Projected changes in temperatures extremes for the Southeast region over 2036–2065 are projected to be 5.79°F for the warmest day of the year compared to the 1976–2005 period.[229] Change in the warmest 5-day, 1-in-10-year event for the same period is 11.09°F.[230] Extreme temperatures in the contiguous United States are projected to increase even more than average temperatures, with heat waves becoming

[223] *Id*. ¶ 34.
[224] *Id*. ¶ 40.
[225] *Id*. ¶¶ 38–40.
[226] CLIMATE SCIENCE SPECIAL REPORT, at 195.
[227] *Id*.
[228] *Id*. at 197, Table 6.4.
[229] *Id*. at 198, Table 6.5.
[230] *Id*.

more intense.[231] Oceans have absorbed about 93 percent of excess heat from global climate change, altering global and regional feedbacks.[232] Surface ocean temperatures have increased by an average of 1.3ºF (.70ºC) from 1900 to 2016.[233]

However, the Southeast region of the U.S. has experienced over .13ºC of surface temperature rise over the same period.[234] The Southeast region is projected to have 1.6 to 2.7ºC of sea surface temperature rise by 2080.[235] The residual heat that the ocean does not absorb causes land and sea ice to melt, which amplifies subsurface ocean warming and ice shelf melting due to increased thermal stratification, which reduces the ocean's ability to transport heat to deep waters.[236] Increased ocean stratification contributes to further ocean warming and mean sea level rise.[237]

Ocean surface waters have become 30 percent more acidic over the past 150 years.[238] Annually, oceans absorb more than a quarter of the CO_2 emitted into the atmosphere from human activities. Under higher emission scenarios, the average surface ocean acidity is projected to increase by 100 to 150 percent. Increased CO_2 in the ocean decreases the amount of carbonate ions available, affecting saturation states for calcium carbonate compounds, which many marine

[231] *Id*. at 202.
[232] *Id.* at 365.
[233] *Id.* at 367.
[234] *Id.* at 368, Table 13.1.
[235] *Id.*
[236] *Id.* at 369.
[237] *Id.*
[238] *Id.* at 372

species use to build shells or skeletons.[239]

Increased air temperatures, due to anthropogenic climate change, have created deficits in surface soil moisture, and surface soil moisture is *likely* to decrease as evaporation will outpace precipitation.[240] However, extreme precipitation events will increase in frequency and intensity throughout the contiguous U.S because of higher atmospheric water vapor concentrations due to increasing atmospheric temperatures.[241] Studies project that increased heavy precipitation will continue into the future; the number of extreme events will increase between 50 to 200 percent the historical average for every region, depending on emission scenario.[242]

Extreme precipitation events in the Southeast region are projected to increase by 9 percent in the lower emission scenario and 12 percent in the higher emission scenario by mid-century. Increased atmospheric water vapor concentration also causes increased precipitation within hurricanes by enhancing moisture convergence into the storm.[243] Hurricanes are responsible for the most extreme precipitation events, especially in southeastern U.S., and those events are predicted to be heavier in the future.[244] Numerical model simulations predict an increase in tropical cyclones (hurricanes and typhoons) in a warmer world, and the models show a general increase in the number of very intense storm events.[245] Temperature and precipitation

[239] *Id.* at 371–72.
[240] *Id.* at 231–47.
[241] *Id.* at 216.
[242] *Id.* at 218.
[243] *Id.* at 222.
[244] *Id.*
[245] *Id.* at 257–76.

extremes are becoming more common, and some have become more frequent, intense, or have longer duration. These extremes have impacts on water quality and availability, agriculture, human health, infrastructure, and on iconic ecosystems and species.[246]

6. A genuine dispute exists over the Applicant's description of the affected environment (10 C.F.R. § 2.309(f)(1)(vi))

Petitioner contends that Applicant's Environment Report "fails to contain information on a relevant matter as required by law."[247] Petitioner identifies each such failure below and the supporting reasons for this belief, including various widely-accepted reports on climate change and expert opinions on the reasonably foreseeable affected environment. These failures create a genuine dispute on material issues of law and fact because, at a minimum, they render Applicant's analyses of environmental impacts of alternatives under consideration incomplete and incorrect in violation of NEPA.

c. *Section 3.3 of Applicant's Environmental Report Fails to Accurately Describe the Meteorology and Air Quality that Will Exist During the License Renewal Period*

The Environmental Report (§ 3.3) omits information about reasonably foreseeable increases in the ambient air temperature during the license renewal period.[248] Applicant's discussion of cumulative impacts from climate change omits this information as well.[249]

Increased temperatures can affect whether Units 3 and 4 are able to operate in the

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[246] *Id.* at 18.
[247] 10 C.F.R. § 2.309(f)(1)(vi).
[248] *See e.g.,* FEIS for Units 6 and 7, at 2-212 ("The projected change in temperature by 2100, which encompasses the period of the licensing action in the southeastern United States is a regional average increase of between 4°F to 8°F in the annual average temperature.").
[249] ER, at 4-66, 4-69 (omitting information about reasonably foreseeable increases in sea level).

configuration described in the Environmental Report. Namely, higher temperatures affect the cooling canal system's heat exchange capacity either directly, by warming the water, or indirectly via degraded water quality.[250] Applicant will need to implement measures for reducing the temperature of water in the cooling canal system to reduce temperatures as they approach the current license limit of 104°F. If the plant cannot run as efficiently as predicted, or at all, if there are high temperatures in the cooling canal system, then the Environmental Report must account for the corresponding difference in power output when considering the purpose and need of the project and the analysis of alternatives.

d. *Section 3.6.1.3 of Applicant's Environmental Report Fails to Accurately Describe the Potential for Flooding During the License Renewal Period.*

Applicant's description of the affected environment's potential for flooding (§ 3.6.1.3) omits relevant information about reasonably foreseeable and significant sea level rise. For example, in the context of its flood hazard reevaluations (not discussed in the ER), Applicant determined that its design-basis flood barriers were "not sufficient when the projected 20 year [initial license renewal period] sea-level rise of 0.39 inches is included and require modification to increase the height of the flood barrier."[251] Though there is *no* dispute that mean sea levels will rise significantly in the reasonably foreseeable future, Applicant fails to discuss this issue or

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[250] ER, at 4-33 (describing various issues that impacted the Cooling Canal System's heat exchange capacity).
[251] FP&L, Letter, "NEI 12-06, Revision 2, Appendix G, G.4.2, Mitigating Strategies Assessment (MSA) for FLEX Strategies report for the New Flood Hazard Information," ADAMS Accession No. ML17012A065 (Dec. 20, 2016), encl. at 16; *see also* Declaration of David Lochbaum (Attachment Q) ¶ 22.

capture this important aspect of the affected environment in its Environmental Report.[252]

Dr. Kopp, Petitioner's expert, opines that even under the best-case emissions scenario, there is greater than two chances in three that sea-level rise will exceed 1 foot in south Florida by 2060.[253] This will dramatically increase the rate of flooding:

> 1.0 feet of average sea-level rise turns the current 50% annual probability high-water level (1.0 feet above Mean Higher High Water) into the new average higher high-water level and the current 1% annual probability high-water level (2.0 feet above Mean Higher High Water) into the new 50% annual probability high-water level. 2.0 feet of average sea-level rise turns the current 1% annual probability high-water level into the new average higher high water level. The effects of this cannot be understated: at Key West, 3.0 feet of sea-level rise is sufficient to turn the highest water level experienced to a flood level expected to be exceeded, on average, half of the days of the year.[254]

Superimposed on higher sea levels, tidal and storm influences will lead to extreme high-water levels at Turkey Point.

If Units 3 and 4 are unable to achieve the stated 1,632 megawatts output due to flooding, then the Environmental Report must account for this diminished output in the discussion of the project's purpose and need as well as the analysis of alternatives.

e. *Section 3.6.2 of Applicant's Environmental Report Fails to Accurately Describe Groundwater Resources that Will Exist During the License Renewal Period.*

Applicant's Environmental Report fails to address the reasonably foreseeable condition

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[252] *See id.*; Pacific Northwest National Laboratory, "Potential Impacts of Accelerated Climate Change, Annual Report of Work for NRC Agreement Number NRC-HQ-60-14-D-0025," ADAMS Accession No. ML16208A282 (May 2016). Applicant's discussion of cumulative impacts similarly omits information about reasonably foreseeable sea level rise. *See* ER, § 4.12.
[253] Kopp Decl. ¶ 38.
[254] Kopp Decl. ¶ 34.

of groundwater resources during the relevant time period, 2032–2053.[255] This failure is material to the NRC's decision. Applicants like FPL whose plants pump "more than 100 gallons (total onsite) of groundwater per minute" must assess the impact of the proposed action on groundwater resources.[256]

Applicants cannot, however, adequately assess groundwater impacts from the operation of the plant during the subsequent license renewal period without first accurately describing groundwater resources during the same period. Applicant states—without explanation—that it does not anticipate increasing groundwater withdrawals beyond currently permitted levels during the renewal period.[257] Because it does not anticipate increasing its groundwater withdrawals, Applicant concludes that environmental impacts from its future withdrawals will remain the same (allegedly small) and do not warrant additional mitigation measures.[258] Applicant's analysis of this issue fails to address, however, whether sufficient groundwater resources will be available during the license renewal period. In fact, it is highly probable that groundwater resources will be inadequate, putting Turkey Point's need for groundwater in conflict with the need for drinking water of the population of South Florida.

CONTENTION 5-E: THE ENVIRONMENTAL REPORT FAILS TO ADDRESS THE ADVERSE EFFECT OF OPERATING THE COOLING CANAL SYSTEM FOR AN ADDITIONAL 20 YEARS ON

[255] Applicant's Supplement to the Environment Report, similarly does not address the reasonably foreseeable future state of groundwater resources. FP&L, "Turkey Point Units 3 and 4 Subsequent License Renewal Application, Appendix E Environmental Report Supplemental Information," ADAMS Accession No. ML18102A521 (Apr. 10, 2018).

[256] 10 C.F.R. § 51.53(c)(3)(ii)(C); Applicant admits groundwater use conflicts are a relevant Category 2 issue in this proceeding. ER, at 4-9.

[257] ER at 4-23.

[258] *Id.*; FP&L, "Turkey Point Units 3 and 4 Subsequent License Renewal Application, Appendix E Environmental Report Supplemental Information," ADAMS Accession No. ML18102A521 (Apr. 10, 2018), encl. Attachment 1, at 4 (concluding Turkey Point groundwater withdrawals are small and do not warrant additional mitigation measures).

SURFACE WATERS, FRESHWATER WETLANDS, AND ENDANGERED SPECIES PRESENT IN THOSE WETLANDS

1. Statement of the issue of law or fact to be raised or controverted (10 C.F.R. § 2.309(f)(1)(i))

NRC regulations require the Environmental Report to consider the effects of Turkey Point's continued operation on surface waters, freshwater wetlands, and endangered species present in those wetlands.[259] But the ER gives no consideration to how the salinization of freshwater wetlands caused by the cooling canal system will impact threatened or endangered species, and otherwise harm important plant and animal habitats. This failure violates NEPA.

2. Brief explanation of the basis for the contention (10 C.F.R. § 2.309(f)(1)(ii)) and concise statement of facts or expert opinions which support Petitioners' position and on which Petitioners intend to rely at hearing (10 C.F.R. § 2.309(f)(1)(v))

Operation of the cooling canal system causes salt and other pollutants to migrate into the groundwater surrounding the cooling canals.[260] Heat from Units 3 and 4 causes evaporation of water in the cooling canals that concentrates salt, creating a hypersaline environment in the canals. The relatively denser saline water leaches out of the cooling canal system and into the aquifer, creating a "hypersaline plume." [261] This process and associated environmental impacts have been recognized by the NRC, the State of Florida, and Miami-Dade County.[262]

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[259] 10 C.F.R. § 51.53(c)(3)(ii)(E) (ER must consider the "impact of refurbishment, continued operations, and other license renewal-related construction activities on important plant and animal habitats" and "on threatened or endangered species"); *see also id.* § 51.53(c)(3)(ii)(B) (ER must consider impacts on fish and shellfish resources resulting from thermal changes and impingement and entrainment).
[260] ER, at 3-82, 3-111.
[261] ER, at 3-111.
[262] *See infra* notes 114, 137.

Over the last four decades, the portion of the Biscayne Aquifer below the cooling canal system has become saturated with hypersaline water moving down into the aquifer and radially in all directions, including westward (*i.e.*, towards the Model Lands Basin, the wider Everglades, and drinking water wells screened in the Biscayne Aquifer), and eastward towards Biscayne Bay where the plume discharges to the surface water.[263]

Salt migrating out of the cooling canal system has formed a hypersaline plume and has moved the saltwater/freshwater interface westwards at all elevations in the Biscayne Aquifer.[264] Operation of the cooling canal system has driven the saltwater/freshwater interface at the base of the aquifer several miles westward into what was previously a potable portion of the aquifer.[265]

The cooling canal system is bounded to the west, southwest, south, and northwest by extensive freshwater wetlands that form part of the Everglades. The nearest wetland watershed unit is called the Model Lands Basin and consists primarily of publicly owned, undeveloped freshwater wetlands that are important habitat for plants and animals, including multiple endangered species.[266] Endangered species that depend on this wetland habitat include the Florida panther, American crocodile, indigo snake, snail kite, red knot and wood stork.[267] The Model Lands Basin also contains the company's Everglades Mitigation Bank.

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[263] *See* NRC, License Amendment To Increase the Maximum Reactor Power Level, Florida Power & Light Company, Turkey Point, Units 3 and 4, Final Environmental Assessment and Finding of No Significant Impact, 77 Fed. Reg. 20059, 20062 (Apr. 3, 2012) ("Because the PTN canals are unlined, there is an exchange of water between the PTN canal system and local groundwater and Biscayne Bay" including a seasonal "flow of hypersaline water from the CCS toward the Everglades").
[264] Chin, David A, Ph.D., *The Cooling System at the FPL Turkey Point Power Station* at 12 (2015) (Attached hereto as Exhibit O).
[265] *Id*. at 12-13.
[266] ER, at 3-149.
[267] 2017 BiOp, at 44.

The discharge of saline groundwater from the cooling canal system is now degrading those wetlands. According to Miami-Dade County: "The FPL Turkey Point CCS, as well as FPL's Everglades Mitigation Bank are located in the extreme southeast region of the county, in an area that is experiencing significant westward migration of the salt intrusion front at the base of the Biscayne aquifer, and where historically fresh surface water canals have recently been documented with higher conductivity and chloride levels uncharacteristic of fresh water bodies."[268]

The County has also noted that "hydrologic impacts including salt intrusion and groundwater and surface water contamination have been documented on these lands."[269] Measurements recorded in County-owned wetlands west of the canal in April 2018 found that shallow groundwater in the area now exhibits conductivity of more than 5000 microSiemens (µmhos/cm).[270] These conductivity levels are dangerously high for a naturally freshwater environment.[271]

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[268] DERM-FDEP July 2018 Letter, at 2.
[269] *Id.* at 4.
[270] *Id.* at 27, 59.
[271] *See* EPA, *Conductivity*, https://archive.epa.gov/water/archive/web/html/vms59.html (last visited July 27, 2018) ("Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge). . . . The conductivity of rivers in the United States generally ranges from 50 to 1500 µmhos/cm. Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a range between 150 and 500 µhos/cm. Conductivity outside this range could indicate that the water is not suitable for certain species of fish or macroinvertebrates. Industrial waters can range as high as 10,000 µmhos/cm."); *see also* Ami L. Riscassi and Raymond W. Schaffranek, USGS, Flow Velocity, Water Temperature, And Conductivity In Shark River Slough, Everglades National Park, Florida: July 1999 – August 2001 (2002), available at https://pubs.usgs.gov/of/2003/ofr03348/ (Appendix C records specific conductance in the range of 300 to 500 µmhos/cm over two years of observations).

Further, recent salinity measurements in the L-31 canal west of the interceptor ditch indicate that saline water from the plume has surfaced in and entered the L-31 canal, from which it can now enter adjacent freshwater wetlands, causing further degradation of the wetlands.[272] As the County explains, "The water quality of the L-31 E was initially freshwater and salinities during the period of record have increased to over 29 PSU."[273] Over the past ten years, canal salinities have trended upward and the highest salinities (29 PSU) were recorded during the first quarter of 2018.[274] Some of this information thus post-dates Applicant's Environmental Report, and none of this information has been previously considered by the NRC.

Turkey Point discharges other pollutants from the cooling canal system to nearby surface waters via the Biscayne Aquifer. Specifically, violations of surface water ammonia standards have been observed in canals near Turkey Point.[275] In the ER, Applicant claims that ammonia detected in surface water is not the result of point or non-point source contamination attributable to Turkey Point.[276] Miami-Dade County, however, has offered evidence that Turkey Point is a key source of the ammonia and is responsible for the violations of water quality standards.[277] Ammonia can have direct and highly toxic effects on the aquatic environment,[278] yet the ER fails

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[272] DERM-FDEP July 2018 Letter, at 3, 26, 51; NRC, "Environmental Impact Statement for Combined Licenses for Turkey Point Nuclear Plant Units 6 and 7," Appendix I at I-6 (describing harm to wetland vegetation caused by the advance of brackish water farther inland).
[273] DERM-FDEP July 2018 Letter, at 3.
[274] *Id.* at 55, 56.
[275] Letter from Wilbur Mayorga (Miami-Dade County, Division of Environmental Resources Management) to Matthew J. Raffenberg (FPL) at 1-2 (July 10, 2018) (Attachment P) ("Mayorga – Raffenberg Letter").
[276] ER, at 9-13, 3-93 -94.
[277] Mayorga – Raffenberg Letter at 1-2.
[278] Final Aquatic Life Ambient Water Quality Criteria for Ammonia – Freshwater 2013, 78 Fed. Reg. 52192,

to consider the impacts of ammonia discharges on threatened and endangered species and important habitat.[279]

3. The issue raised in the contention is within the scope of the proceeding (10 C.F.R. § 2.309(f)(1)(iii))

NRC regulations plainly require the ER to address the effects of Turkey Point's continued operations on surface waters, freshwater wetlands, and endangered species.[280] The effects on these resources of the Turkey Point's cooling canal system are therefore within the scope of this proceeding.

4. The issue raised in the contention is material to the findings the NRC must make to support the action involved in the proceeding (10 C.F.R. § 2.309(f)(1)(iv))

A contention is "material" to the NRC's duty to make environmental findings if the issue of law or fact it raises "is of possible significance to the result of the proceeding. This means that there should be some significant link between the claimed deficiency and either the health and safety of the public or the environment."[281]

There is a significant link between the issue raised in this contention—FPL's failure to assess the impacts of Turkey Point's operations on surface waters, freshwater wetlands, and threatened and endangered species—and "the health and safety of the public or the environment."[282] NRC regulations require the ER to include such an analysis. Each aspect of

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52192 (Aug. 22, 2013)

[279] 10 C.F.R. § 51.53(c)(3)(ii)(E) and (B).

[280] *See, e.g.*, 10 C.F.R. § 51.53(c)(3)(ii)(E) (ER must consider "impact of refurbishment, continued operations, and other license renewal-related construction activities on important plant and animal habitats" and "on threatened or endangered species"); *id.* § 51.53(c)(3)(ii)(B) (ER must consider impacts on fish and shellfish resources resulting from thermal changes and impingement and entrainment).

[281] *In re Entergy Nuclear Vt. Yankee L.L.C. & Entergy Nuclear Operations*, 60 N.R.C. 548, 556–57, 2004 NRC LEXIS 247, *16-17 (N.R.C. November 22, 2004).

[282] *Id.*

the contention relates directly to an impact on the public health or the environment and, thus, is material to the findings the NRC must make to support relicensing.

5. A genuine dispute of material fact or law exists over the Environmental Report's analysis (10 C.F.R. § 2.309(f)(1)(vi))

Where the intervenor alleges that a license renewal application does not address a relevant matter, a genuine dispute of material fact or law exists if the intervenor explains why the application is deficient.[283] Petitioners meet this standard. Here, the Applicant has failed to give any consideration to the impacts that groundwater salinization caused by the Turkey Point cooling system could have on surface waters, freshwater wetlands and the plants and animals that live there, including threatened and endangered species. Applicant states that studies it conducted "to determine the influence of the cooling canals on the surrounding areas through migration of groundwater" demonstrate that "the cooling canals do not have any ecological impact on the surrounding areas."[284] Applicant's discussion of "Threatened, Endangered, and Protected Species, and Essential Fish Habitat" did not even consider the effects of salinization of freshwater wetlands west of Turkey Point.

Petitioners have cited authoritative government documents that establish that Applicant's analysis does not comply with NRC regulations.[285] These analyses plainly evidence saltwater intrusion into historically fresh surface water canals and wetlands.[286] Furthermore, there is a genuine dispute as to the impact of ammonia on nearby surface waters.

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[283] 54 Fed. Reg. at 33,170.
[284] ER, at 4-69.
[285] 10 C.F.R. § 51.53(c)(3)(ii)(E) and (B).
[286] *See, e.g.*, DERM-FDEP July 2018 Letter, at 2.

CONCLUSION

For the reasons stated above, Petitioners should be admitted as parties to the proceeding to pursue the admissible contentions they have presented.

Respectfully submitted,

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Filed this 1st day of August, 2018

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	
FLORIDA POWER & LIGHT COMPANY	)	Docket No. 50-250
	)	Docket No. 50-251
(Turkey Point Nuclear Generating Station, Unit Nos. 3 and 4)	)	August 1, 2018
	)	
(Subsequent License Renewal Application)		

CERTIFICATE OF SERVICE

Pursuant to 10 C.F.R. § 2.305, I certify that, on this date, a copy of the foregoing "*Request For Hearing And Petition To Intervene Submitted By Friends Of The Earth, Natural Resources Defense Council, And Miami Waterkeeper*" was served upon the Electronic Information Exchange ("EIE," the NRC's E-Filing System), in the above-captioned docket, which to the best of my knowledge resulted in transmittal of same to those on the EIE Service List for the captioned proceeding.

/Signed (electronically) by/
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August 1, 2018

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	)	
	)	
(Subsequent License Renewal Application)	)	

PETITIONERS' CORRECTED RESPONSE TO APPLICANT'S SURREPLY

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INTRODUCTION

As may be permitted by the Atomic Safety and Licensing Board ("ASLB")[1], Southern Alliance for Clean Energy ("SACE"), Natural Resources Defense Council ("NRDC"), Friends of the Earth ("FoE"), and Miami Waterkeeper ("MWK") (hereinafter "Petitioners") hereby respond to Applicant's Surreply to New Arguments Raised in Reply Pleadings (Sept. 20, 2018) ("Surreply"). The Applicant, Florida Power & Light ("FPL"), asks the ASLB to disregard the plain language of 10 C.F.R. § 51.53(c)(3), which restricts the applicability of that regulation to "applicants seeking an *initial* renewed license." But FPL's arguments are without merit.

ARGUMENT

I. FPL'S INTERPRETATION OF 10 C.F.R. § 51.53(c)(3) VIOLATES BASIC PRINCIPLES OF STATUTORY INTERPRETATION.

FPL does not dispute that the plain language of the phrase "applicants seeking an initial renewed license" means applicants seeking a renewed license directly following an initial 40-year license term; nor does FPL deny that the phrase, if applied to FPL's subsequent license renewal application, would preclude FPL from relying on § 51.53(c)(3) to avail itself of the binding Category 1 exclusions in Table B-1 of Appendix A to 10 C.F.R. Part 51. Instead, FPL urges the ASLB to disregard the plain language of § 51.53(c)(3) and apply the Category 1 exceptions to FPL's subsequent license renewal application anyway. FPL's various arguments violate the bedrock principles guiding adjudicatory bodies in construing statutes and legislative rules. And FPL has failed to justify any exception to these principles.

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[1] Petitioners have filed a motion for leave to file this response to FPL's Surreply. *See* Motion for Leave to Respond to Surreply (Oct. 1, 2018).

The paramount rule of construction is that when construing legislative text,[2] "we look first to its language, giving the words used their ordinary meaning." *Artis v. District of Columbia*, 138 S. Ct. 594, 603 (2018). "There is, of course, no more persuasive evidence of the purpose of a statute than the words by which the legislature undertook to give expression to its wishes." *United States v. Am. Trucking Assns., Inc.*, 310 U.S. 534, 543 (1940); *see also Puerto Rico v. Franklin Cal. Tax-Free Tr.*, 136 S. Ct. 1938, 1946 (2016) (Where a "statute's language is plain," resolution of a disputed issue "begins with the language of the statute itself, and that is also where the inquiry should end." (internal quotation marks omitted)). The Supreme Court has repeatedly made clear that the "plain meaning" of a legislative text is "conclusive, except in the 'rare cases'" in which such an interpretation would "produce a result *demonstrably at odds with the intentions of its drafters*." *Griffin v. Oceanic Contractors, Inc.*, 458 U.S. 564, 571 (1982) (emphasis added).

In violation of this principle, FPL urges the Board to go beyond the plain language of § 53(c)(3) and disregard *entirely* the clear, unambiguous language of the regulation. In essence, FPL contends that "initial renewed license" means "*any* type of renewed license, including initial or subsequent." But FPL's interpretation—in addition to violating the cardinal rule of legislative construction by ignoring the plain language of the regulation—would read the crucial limiting word "initial" out of the regulation. FPL's argument violates the cardinal rule of statutory construction that "effect must be given, if possible, to every word, clause and sentence." *United States v. Menasche*, 348 U.S. 528, 538–39 (1955); *see also Wrangler Laboratories, et. al.,*

[2] Canons of statutory construction apply with equal force to construction of regulations. *Nat'l Ass'n of Home* Builders *v. Defs. of Wildlife*, 551 U.S. 644, 668 (2007); *Long Island Care at Home, Ltd. v. Coke*, 551 U.S. 158, 170 (2007).

ALAB-951, 33 N.R.C. 505, 513–14 (1991) (quoting *Long Island Lighting Co.* (Shoreham Nuclear Power Station, Unit 1), ALAB-900, 28 N.R.C. 275, 288 (1988)).

FPL's proposed interpretation of § 51.53(c)(3) to apply to all license renewal applicants would also negate the meaning of other language in the regulation. In addition to being limited to "initial" license renewals, the benefit to applicants from § 51.53(c)(3) is also limited to applicants that "hold[] an operating license . . . as of June 30, 1995." To adopt FPL's argument that § 51.53(c)(3) must be applied to *all* subsequent license renewal applicants would require the ASLB to ignore this unambiguous language as well. But the ASLB may not construe the regulation "in a way that negates its plain text." *Honeycutt v. United States*, 137 S. Ct. 1626, 1635 n.2 (2017); *see also Nat'l Ass'n of Home Builders*, 551 U.S. at 668–69 (court cannot interpret a regulation to render part of it surplusage); *Gardebring v. Jenkins*, 485 U.S. 415, 430 (1988) (court should reject agency's interpretation of its own statute in favor of an alternative if that alternative "is compelled by the regulation's plain language").

II. FPL FAILS TO JUSTIFY ANY EXCEPTION TO THE PLAIN MEANING RULE.

FPL does not dispute the general applicability to NRC proceedings of the "plain meaning rule," *i.e.,* that "the starting point in construing a statute (or a regulation) is the language of the statute or regulation itself, and that if that language is plain and unambiguous, then it must be applied according to its terms."[3] But FPL claims this case falls under "one generally recognized exception," for circumstances where application of the plain meaning of a regulation would

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[3] FPL Surreply at 4 and n.12 (citing *Northeast* Nuclear *Energy Co.* (Millstone Nuclear Power Station, Unit 3), CLI-01-10, 53 N.R.C. 353, 361 (2001); *Hydro Res., Inc.,* (P.O. Box 777, Crownpoint, New Mexico 87313), CLI-04-11, 63 N.R.C. 483, 491 (2004)).

"produce an 'absurd' or 'unintended' result."[4]

This exception, however, is "rarely applied, because the result produced by the plain meaning canon must be *truly absurd* before this principle trumps it. Otherwise, clearly expressed legislative decisions would be subject to the policy predilections of judges." *Merritt v. Dillard Paper Co.*, 120 F.3d 1181, 1188 (11th Cir. 1997) (emphasis added). It is not enough to rely on "broad [statutory] purposes" to justify ignoring specific language whose meaning is unambiguous. *Int'l Bhd. of Teamsters v. Interstate Commerce Com.*, 801 F.2d 1423, 1430 (D.C. Cir. 1986), *on reh'g,* 818 F.2d 87 (D.C. Cir. 1987) (rejecting the Interstate Commerce Commission's attempt to ignore unambiguous statutory language). The exception is even less appropriate to apply where, as here, a court is asked to violate another cardinal rule of statutory construction—that "effect must be given, if possible, to every word, clause and sentence." *Menasche*, 348 U.S. at 538–39. FPL utterly fails to justify an exception to the plain language rule here.

A. There Is Nothing Absurd, Let Alone *Truly* Absurd, About Giving § 51.53(C)(3) Its Plain and Ordinary Meaning.

Application of the plain meaning of § 51.53(c)(3) to exclude subsequent license renewal applicants yields a logical result, not an absurd result. There is nothing "absurd" or even illogical about requiring a subsequent license renewal applicant to analyze Category 1 environmental issues on a site-specific basis. The 1996 GEIS focused only on the environmental impacts of the first twenty years following the initial license term, and the 2013 Revision to the

[4] *Id.*

GEIS did nothing to expand on that temporal scope. Therefore, it would be *illogical* to apply the Category 1 exemptions to a second license renewal term whose environmental impact had never been analyzed in an EIS.[5]

1. The temporal scope of the 1996 GEIS is clearly limited to the 40-year initial license term plus one renewal term.

The limited temporal scope of the 1996 GEIS is clear. As a general matter, it states:

> This GElS examines how these plants and their interactions with the environment would change if such plants were allowed to operate (under the proposed license renewal regulation 10 CFR Part 54) *for a maximum of 20 years past the term of the original plant license of 40 years*.[6]

And the limited temporal scope of the 1996 GEIS' findings undergirding Table B-1 is repeated in specific environmental analyses. For instance, the Category 1 designation of "radiation exposures to the public" in Table B-1 is based on the conclusion that "[r]adiation doses to the public from continued operations and refurbishment associated with license renewal are expected to continue at current levels, and would be well below regulatory limits." This finding is based, in turn, on the environmental analysis in Section 2.6 of the 1996 GEIS, which assumes that the license to be renewed is the initial operating license. As stated in Section 2.6.2.2:

> The generic license renewal programs utilized in this evaluation were based on similar schedules for carrying out the selected aging management activities. Any major refurbishment work called for by the programs was assumed to start shortly after a renewed license had been granted. *In these example programs, this would occur in roughly year 30 of the original 40-year license term. This work was assumed to be completed over several successive outages, including one at the end of the 40th year of plant*

[5] To be clear, Petitioners *do not* challenge the content or conclusions of the GEIS.

[6] 1996 GEIS at 2-1 (emphasis added).

operation.[7]

NRC carried this temporal limit throughout the 1996 GEIS for a range of environmental impacts.[8] Thus, the 1996 GEIS analyzes the effects of adding a 20-year term to an original 40-year license term, and no more.[9]

2. The NRC did not expand the temporal scope of the License Renewal GEIS in the 2013 Revised GEIS.

The 2013 Revised License Renewal GEIS did not change this temporal scope. Instead, it simply re-evaluated and confirmed the previous findings. For instance, the 2013 Revised GEIS asserts that the 1996 GEIS' conclusions regarding the environmental impacts of refurbishment activities are "valid and conservative."[10] And the 2013 Revised GEIS concludes that "[d]uring the license renewal term, commercial nuclear power plants would continue to operate in the

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[7] 1996 GEIS at 2-34 (emphasis added). *See also* Section 2.6.2.7, where the 1996 assumes that a renewed license would be "covering the balance of the original 40-year term, as well as the additional 20-year term." *Id.* at 2-36.

[8] *See, e.g., id.* at 7-1 – 7-17 (decommissioning); *id.* at 3-39 (radiation protection); *id.* at 4-59 (transmission lines); *id.* at 4-85 (public radiation doses). A 40-year term of reactor operation is assumed throughout as the "base case" or "baseline." *Id.* at 7-1, 7-10, 7-14, 4-85.

[9] Further confirmation of the NRC's intent to limit the temporal scope of the 1996 GEIS can be found in a clarifying amendment to the 1996 rule, promulgated later that year. Final Rule, Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, 61 Fed. Reg. 66,537 (Dec. 18, 1996) (making "minor non-substantive changes" to Table B-1 and other provisions). In responding to comments, the NRC referred to "waste currently being generated during the initial license term of power reactors" (*id.* 66,538) and the "attribution of transportation impacts between the initial operating license and the renewed license." *Id.* at 66,539. This language confirms that the only two license terms that were evaluated in the 1996 GEIS or the 1996 rule were the initial license term and the first license renewal term.

[10] 2013 Revised GEIS at 2-3.

same manner as they had during the original license term."[11]

The temporal limitation of the 2013 Revised GEIS to 40 plus 20 years is also evident in the GEIS' discussion of specific types of environmental impacts. With respect to occupational radiation exposures, for example, the 2013 Revised GEIS states:

> During 2005, with occupational radiation protection programs in place, nuclear power plants maintained an annual average individual dose of 0.12 rem and 0.18 rem for PWRs and BWRs, respectively (Table 3.9-11), compared with an exposure limit of 5 rem. For all nuclear power plants combined, the occupational doses to individual workers are estimated to average 0.15 rem/yr (Table 3.9-4). At these dose levels, the average increase in fatal individual cancer risk to a worker is approximately 6 x 10-5/yr (using the ICRP risk coefficient of 4 x 10-4/rem from Table 3.9-20). *If the reactor operates for 60 years, the cumulative increase in fatal cancer to an individual worker is estimated to be 3.6 x 10-3 (a 50 percent increase over the baseline of 40 years of operations).* However, it is very unlikely that the same worker would be employed for all 60 years of plant operations.[12]

The 2013 Revised GEIS contains a similar analysis for public radiation doses. Once again, 40 years is the "baseline" for an environmental analysis that predicts environmental impacts over a subsequent 20-year renewal period:

> Although dose rates (mrem/yr) are not expected to change during license renewal, the cumulative dose (total mrem) would increase as a result of 20 more years of operations. If the reactor operates for 60 years, it is estimated that the increase in fatal cancer risk to the MEI would range from 6 x 10-7 to 4.6 x 10-4 (a 50 percent increase over the baseline of 40 years of operation). However, it is unlikely that the same person would be exposed to these doses for 60 years of plant operations.[13]

On the same topic of environmental impacts of radiation exposures to the public, the 2013

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[11] *Id.*

[12] 2013 Revised GEIS at 4-138 – 4-139 (emphasis added).

[13] *Id.* at 4-145 (emphasis added).

Revised GEIS further states:

> Regulatory Guide 1.109 (NRC 1977) provides guidance for calculating the dose for significant release pathways. To account for the buildup of radioactive materials, buildup factors are included in the calculations. Initially, most of the calculations for the construction and operating stage permits used 15 years as the approximate midpoint of a facility's operating life. This value is now more often taken to be 20 years. The potential license renewal term is an additional 20 years; *thus, the effective midlife is 30 years.*[14]

Along the same lines, with respect to decommissioning, the 2013 Revised GEIS states:

> As discussed in the 1996 GEIS, the dose to the public from long-lived radionuclides after 40 years of plant operation is expected to be negligible, and the increase in quantities of long-lived radionuclides after an additional 20 years would result in a negligible dose (less than 0.1 person-rem). Accordingly, the NRC concluded that the contribution of license renewal to radiological impacts to the public from decontamination would be of SMALL significance at all nuclear plants.[15]

Throughout the 2013 Revised GEIS, the NRC refers to a time frame totaling 60 years, and a baseline of 40 years. *Nowhere* does the 2013 Revised GEIS refer to a time frame totaling 80 years or a baseline of 60 years.

There is nothing surprising, therefore, about a regulatory provision that would preclude a subsequent license renewal applicant from relying on the Category 1 finding in Table B-1. To the contrary, application of the plain meaning of § 51.53(c)(3) would yield a logical result, *i.e.*, to preclude a subsequent license renewal applicant from relying on environmental findings beyond the temporal scope of a second license renewal term. Thus, there is nothing "absurd" about applying the plain language of § 51.53(c)(3) to FPL's subsequent license renewal application.

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[14] *Id*. at 4-144 (emphasis added).

[15] *Id*. at 4-217.

B. The Limitation Of § 51.53(C)(3) To "Applicants Seeking an Initial Renewed License" Is Not Inconsistent with NRC's Entire Regulatory Scheme for Implementation of NEPA in License Renewal Proceedings.

FPL contends that interpreting § 51.53(c)(3) to exclude subsequent license renewal applicants like FPL is inconsistent with the NRC's "entire regulatory scheme."[16] According to FPL, Petitioners' "plain language" interpretation of § 51.53(c)(3) contradicts NRC's regulations for preparing environmental impact statements, which contain no comparable prohibition against applying the Category 1 exclusions of Table B-1 to EISs for subsequent license renewal applicants:

> Section 51.71 governs the content of the Staff's draft (and ultimately final) supplemental environmental impact statement ("SEIS"). Section 51.71(d) provides that "[t]he draft [SEIS] for license renewal prepared under § 51.95(c) *will rely on conclusions as amplified by the supporting information in the GEIS for issues designated as Category 1* in appendix B to subpart A of this part." Section 51.95(c) provides, among other things, that the license renewal SEIS "shall address those issues as required by § 51.71," and "shall integrate the conclusions in the [GEIS] for issues designated as Category 1 with information developed for those Category 2 issues applicable to the plant under § 51.53(c)(3)(ii) and any new and significant information."[17]

But the failure of logic lies with FPL. In promulgating Table B-1, § 51.71, and § 51.95 in 1996, the NRC had no reason to state that the Category 1 exception applied only to initial license renewals, because neither the rule nor the underlying 1996 GEIS applied to anything *other than*

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[16] FPL Surreply at 27 (citing Northeast *Nuclear Energy Co.* (Millstone Nuclear Power Station, Unit 3), CLI-01-10, 53 N.R.C. 353, 366 (2001); *U.S. Dep't of Energy* (High-Level Waste Repository), LBP-04-20, 60 N.R.C. 300, 335 (2004)).

[17] FPL Surreply at 8 (emphasis in original) (footnotes omitted).

initial license renewals (*i.e.*, 40 plus 20 years).[18] The NRC could not allow licensees to rely upon generic review of Category 1 issues beyond the initial license renewal term, because the agency never conducted a generic environmental analysis of impacts beyond the 60-year time frame to justify it. Thus, the NRC had no reason to state that Table B-1 would apply to subsequent license renewal applications (*i.e.*, 60 plus 20 years).[19] The NRC *did* have a reason to notify license applicants that § 51.53(c)(3) (and hence Table B-1) would only apply to the initial license renewal term, however. Having told licensees that "[n]o limit on the number of license renewals is specified" in NRC's Part 54 regulations,[20] the NRC reasonably clarified that the scope of its license renewal review under NEPA would be more limited in § 51.53(c)(3).

FPL suggests that Petitioners' textual argument fails because Table B-1 does not refer to "initial" renewed licenses, only renewed licenses:

> On this point, it bears emphasis that the preamble to Table B-1 refers to the Commission's assessment of "the environmental impacts associated with granting a renewed operating license for a nuclear power plant to a licensee who holds either an operating license or construction permit as of June 30, 1995." Unlike Section 51.53(c)(3), on which Petitioners' entire "plain language" argument hinges, Table B-1 does *not* refer to "initial" renewed licenses.[21]

But FPL stumbles over its own argument. The phrase "renewed operating license" in the

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[18] *See* discussion above in Section II(A)(1).

[19] As discussed below in Section II(A)(2), these circumstances have not changed. The NRC's "update" to the 1996 GEIS in the 2013 Revised GEIS did not extend the temporal scope of the 1996 GEIS beyond the initial license renewal period.

[20] 1996 GEIS at 1-1.

[21] FPL Surreply at 8 (emphasis in original).

Table B-1 preamble cannot be read to govern *all* operating licenses because it expressly excludes *some* renewed licenses, *i.e.*, post-1995 licensees. The only reasonable and logical interpretation of this preamble when read in conjunction with § 51.53(c)(3) is that the preamble only applies to a pre-1995 licensee's "initial" license renewal application. No other construction would give effect to every word.[22] In any event, even assuming for purposes of argument that there were any inconsistency between § 51.53(c)(3) and the overarching purposes of NRC's regulations for NEPA review, such an inconsistency would not give the ASLB broad authority to effectively re-write the regulation. The "felt necessities of the [rulemaking] process inevitably produce more narrowly focused provisions which fail in full rigor to effectuate the overarching goal." *See Int'l Bhd. of Teamsters*, 801 F.2d at 1430 ("And the hard fact remains that it is not the judiciary's assigned task to sit as a modernday Council of Revision . . . and to *cy pres* statutory provisions that may not be in full keeping with the spirit that has more recently animated Congress.").

1. The History of the NRC's License Renewal Regulations Contains No Evidence of any Intent by the Commission to Alter or Disregard the Plain Meaning of § 51.53(c)(3).

FPL acknowledges that in the 1991 proposed rule, where the NRC first proposed to include the phrase "applicants seeking an initial renewed license" in 10 C.F.R. § 51.53(c)(3), that the NRC explicitly intended to limit the scope of license renewal environmental reviews to the

[22] FPL suggests, incorrectly, that Petitioner SACE argues that §§ 51.53(c)(2) and 51.53(c)(3) are "mutually exclusive." FPL Surreply at 7. But Petitioners only argue that § 51.53(c)(3) is limited to the initial license renewal application. Thus, while a pre-1995 licensee seeking an initial license renewal may rely on § 51.53(c)(3), a subsequent license renewal applicant may not.

first twenty-year renewal term after the initial forty-year term.[23] According to FPL, however, the NRC abandoned that intention as early as the final 1996 version of the rule, which "*omits*" any similar representations, *i.e.,* it does not use the phrase 'one renewal of the initial license' or 'up to 20 years beyond the expiration of the initial license.'"[24] Thus, according to FPL, the phrase "initial license renewal applicants," as used in § 51.53(c)(3), constitutes a "residual reference," *i.e.*, a meaningless historical artifact. But FPL does not cite a single word or phrase to show that the inclusion of this phrase in the regulation was a mistake. And in fact, the regulatory history of the NRC's regulations for NEPA review of license renewal applications contradicts FPL.

a. The regulatory history of NRC's NEPA rules and GEIS for license renewal contain no reference to the concept of subsequent license renewal.

Tellingly, FPL does not identify even a single reference to the concept of subsequent license renewal in the 1996 Final Rule, the 2009 proposed amendments to the 1996 Final Rule, or the 2013 Final Rule amending the 1996 rule. Nor does FPL point to a single reference to the concept of subsequent license renewal in the 1996 GEIS, the 2013 Revised GEIS, or the draft versions of those documents. And no such references can be found. In fact, the regulatory history of § 51.53(c)(3), the License Renewal GEIS, and the NRC's regulations for the implementation of NEPA in license renewal cases demonstrates unequivocally that the inclusion of the phrase "applicants seeking an initial renewed license" in past and current versions of

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[23] Surreply at 6 (citing SACE reply at 4 and quoting Proposed Rule, Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, 56 Fed. Reg. 47,016, 47,017 (Sept. 17, 1991)).

[24] Surreply at 6 (emphasis in original) (citing Final Rule, Environmental Review for Renewal of Nuclear Power Plant Operating Licenses 61 Fed. Reg. 28,467 (June 5, 1996)).

§ 51.53(c)(3) was indeed intentional; and that NRC never considered applying § 51.53(c)(3) or the generic Category 1 findings of Table B-1 to any license renewal term other than the first twenty-year renewal term following an initial 40-year license term.

b. The history of § 51.53(c)(3) contradicts FPL's argument.

FPL would have the ASLB disregard the inclusion of the phrase "applicants seeking an initial renewed license," as used in § 51.53(c)(3) as an oversight that the NRC should have corrected when it changed course after the 1991 proposed rule and decided to include multiple license renewal terms in the final 1996 rule. But the rulemaking history of § 51.53(c)(3) shows that the NRC repeatedly carried over that same phrase from the 1991 proposed rule into the 1996 final rule, the 2009 proposed amendments to the 1996 final rule, and the 2013 final amendments to the 1996 rule. *See* Final Rule, 61 Fed. Reg. at 28,487; Proposed Amended Rule, 74 Fed. Reg. 38,117, 38,128, 38,132 (July 31, 2009); and Final Amended Rule, 78 Fed. Reg. 37,312, 37,316 (June 20, 2013). It is absurd for FPL to characterize the inclusion of the phrase "applicants seeking an initial renewal term" in three separate rulemaking notices following the 1991 Proposed Rule as "residual."

i. <u>The 1996 Final Rule and 1996 GEIS specifically state that the NRC's generic environmental analysis for license renewal, including Category 1 designations, covers only the initial license renewal term.</u>

FPL's claim that the 1996 final rule contains no reference to a single license renewal term is incorrect.[25] The 1996 Final Rule directly references the NRC's assumption that its environmental review for license renewal covered only the first renewal term, with respect to decommissioning impacts:

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[25] *See* FPL Surreply at 6.

> The analysis in the GEIS for license renewal examines the physical requirements and attendant effects of decommissioning after a 20-year license renewal compared with decommissioning at the end of 40 years of operation and finds little difference in effects.

Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, 61 Fed. Reg. 28,467, 28,482 (June 5, 1996). Equally importantly, the 1996 Final Rule codifies and relies on the findings of the 1996 GEIS. *Id*. at 28,467 (stating that the rule is "based on the analyses conducted for and reported in NUREG–1437, ''Generic Environmental Impact Statement for License Renewal of Nuclear Plants'' (May 1996)). The GEIS, in turn, explicitly describes the "proposed action" addressed by its analysis as allowing nuclear power plants to operate "for a maximum of 20 years past the terms of their *original* 40-year operating licenses."[26] *See also* discussion above in Section II(A).

ii. The NRC did not expand the temporal scope of the 1996 GEIS when it prepared the 2013 Revised GEIS.

FPL argues that the 2013 Revised GEIS expands the scope of the environmental analysis

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[26] 1996 GEIS at 2-28–29 (emphasis added). FPL argues that restricting the scope of the GEIS to the first license renewal term is illogical in light of the NRC's stated intention to update the GEIS every ten years after issuance of the 1996 GEIS. FPL Surreply at 6 (citing Table B-1). But there is nothing illogical or inconsistent about making such a plan for initial license renewal reviews. At the time the 1996 rule was promulgated, none of the licenses for more than 100 operating reactors had been renewed, and indeed all plans for license renewal were awaiting promulgation of regulations that would allow them to go forward. Thirteen years later (in 2009), about half (51) of reactor licenses had been renewed. Proposed Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, 74 Fed. Reg. 38,117, 38,119 (Jul. 31, 2009). Had the NRC stayed on schedule and actually revised its GEIS every ten years after 1996 as originally planned, the License Renewal GEIS would have been revised several times before all original operating licenses were renewed for an initial renewal term.

to include a second license renewal term.[27] As discussed above in Section II(A)(2), however, the 2013 Revised GEIS contains no evidence of such an expansion, and indeed is replete with statements showing that the NRC assumed the same time frame as the 1996 GEIS: the original 40-year term plus an additional 20 years. Throughout the 2013 Revised GEIS, the NRC refers to a time frame totaling 60 years, and a baseline of 40 years. *Nowhere* does the 2013 Revised GEIS refer to a time frame totaling 80 years or a baseline of 60 years.

Thus, the use of the term "current" in the 2013 Revised GEIS does not signify any change from the use of the same term in the 1996 GEIS to describe the original license term.[28]

C. FPL's Proposed Interpretation of § 51.53(c)(3) is Inconsistent with NRC's Regulatory Scheme for Preparation of EISs, Including the Scoping Process.

FPL argues that depriving subsequent license renewal applicants of Category 1 exclusions would "make no practical sense" in light of the Commission's goal of using the Category 1 designations to make the license renewal process more efficient.[29] But the NRC could not have subordinated its specific procedural regulations to a general goal of efficiency. And the record contains no evidence that the NRC used its scoping process to expand the scope of the 1996 GEIS in the 2013 Revised GEIS.

In the process of scoping an EIS, the NRC must, *inter alia,* "[d]efine the proposed action"

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[27] FPL Surreply at 10–11.

[28] FPL makes much of the fact that the 2013 Revised GEIS uses the phrase "current license term," leaving open to interpretation whether the NRC meant that the agency was considering an addition to the original license term or to an already-renewed license term. FPL Surreply at 10. But the 1996 GEIS uses the phrases "current license term," "current license period," and "current license" throughout to refer to the original license term. *See, for example,* 2013 Revised GEIS at xxxvii-xliii, 1-2, 1-6, 2-36, 2-37, 2-48, 3-6, 3-50, 4-55, 4-123 – 4-127, 5-1, 5-97, 6-37.

[29] FPL Surreply at 9.

(10 C.F.R. § 51.29(a)(1)), "[d]etermine the scope of the statement" (10 C.F.R. § 51.29(a)(2)), and "identify the significant issues to be analyzed in depth." *Id.* As discussed above in Section II(A)(1), the record of the 1996 GEIS shows that the temporal scope of that GEIS was limited exclusively to the first license renewal term after the initial operating license term. FPL cannot point to a single word in either the scoping notice for the 2009 proposed amendments to the 1996 final rule or the 2009 draft revised GEIS that (a) re-defined the proposed action as extending reactor operating licenses for multiple 20-year terms, (b) stated that the scope of the 2013 Revised GEIS would cover multiple license renewal terms, or (c) identified or sought public comment on the significant issues that should be analyzed in the course of the expanded environmental review. Instead, the only action proposed by the NRC was to "update" the 1996 GEIS. Notice of Intent to Prepare an Environmental Impact Statement for the License Renewal of Nuclear Power Plants and to Conduct Scoping Process, 68 Fed. Reg. 33,209 (June 3, 2003).

FPL's inability to point to a scoping process that expanded the scope of the License Renewal GEIS fundamentally undermines any claim to a temporal expansion, because the scope of an EIS determines the scope of the federal action that may be taken under the authority of that EIS. *Duke Power Co. (Oconee/McGuire),* LBP-80-28, 12 N.R.C. 459, 473 (1980) (citing *Swain v. Brinegar,* 542 F.2d 364, 367 (7th Cir. 1976)). Here, the scope of the 1996 GEIS, as updated in the 2013 Revised GEIS, is limited to the first license renewal term after the original operating license term. Therefore, the NRC may not take the federal action of applying the Category 1 exclusions in Table B-1 to any license renewal applications other than initial license renewal applications. The NRC may still *refer* to the environmental findings of the 2013 Revised GEIS in a subsequent license renewal review, but NEPA prohibits the NRC from *codifying* those findings for purposes of a subsequent license renewal review.

III. INTERNAL NRC MEMORANDA AND POLICY STATEMENTS CANNOT SUBSTITUTE FOR NOTICE-AND-COMMENT RULEMAKING, SCOPING PROCESS, AND A NEW DRAFT GEIS FOR LICENSE RENEWALS.

As discussed above, a formal notice-and-comment rulemaking led to the original and still-current language in § 51.53(c)(3). That language is plain in limiting the scope of the regulation to initial license renewal applications. If FPL wishes to change that language, it must petition for a rulemaking and ask the NRC to prepare a new or revised License Renewal GEIS. No intervening memoranda, policy statements, or GEIS can change that. *See, e.g., Perez v. Mortg. Bankers Ass'n*, 135 S. Ct. 1199, 1206 (2015) ("agencies [must] use the same procedures when they amend or repeal a rule as they used to issue the rule in the first instance."). The "convenience" of avoiding notice-and-comment rulemaking "comes at a price: Interpretive rules 'do not have the force and effect of law and are not accorded that weight in the adjudicatory process.'" *Id.* at 1204 (internal citations omitted). This is black letter law.[30]

[30] FPL's argument that reference in SECY-12-0063 to the potential filing of subsequent license renewal applications overrides the scoping notice and summary report for the 2013 Revised GEIS -- which contain no reference whatsoever to the concept of subsequent license renewal or any license renewal term beyond the first twenty years -- is inconsistent with NRC regulations and case law interpreting NEPA. Surreply at 11 n.40 (citing SECY-12-0063, Final Rule: Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses (Apr. 20, 2012) (ML110760033)). Accuracy in the initial scoping of an EIS is critical because a proposed federal action may not exceed the scope of its supporting EIS. *Duke Power Co.,* 12 N.R.C. at 473. Hence, the NRC must conduct a scoping process "as soon as practicable after publication of the notice of intent" and use it to "[d]efine the proposed action which is to be the subject of the statement or supplement." 10 C.F.R. §§ 51.29(a) and 51.29(a)(1). Public participation is also an important element of the scoping process, and therefore NRC regulations require that a broad range of affected parties, including individuals and organizations, government agencies, and Indian tribes, must be notified and invited to participate. 10 C.F.R. § 51.28. To disregard the content of the scoping notice for the 2013 Revised GEIS or the results of the scoping process would defeat the purpose of these regulations.

A. NRC Internal Memoranda Do Not Substitute for NEPA Compliance or Notice-and-Comment Rulemaking.

The only NRC documents that FPL can point to which actually mention subsequent license renewal in the context of the NRC's NEPA review are three NRC memoranda: SECY-12-0063; SECY-14-0016, Ongoing Staff Activities to Assess Regulatory Considerations for Power Reactor Subsequent License Renewal (Jan. 31, 2014) (ML14050A306), and SRM-SECY-14-0016 – Ongoing Staff Activities to Assess Regulatory Considerations for Power Reactor Subsequent License Renewal (Aug. 29, 2014) (ML14241A578) ("SRM-SECY-14-0016").[31] None of these internal NRC memoranda could substitute for the notice-and-comment rulemaking, scoping process, and new draft GEIS for license renewal that the NRC *must* undertake if it wishes to apply the Category 1 exclusions to subsequent license renewal applications. *See Perez*, 135 S. Ct. at 1206.

In any event, the internal memoranda do not come close to addressing the issue of whether the NRC is entitled to ignore the plain language of § 51.53(c)(3) or the temporal limitations of the 1996 GEIS as revised in 2013. They simply acknowledge that licensees will become eligible for a second license renewal term and that the NRC should establish guidance for the proceedings.

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[31] FPL Surreply at 11–13.

B. Absent a New Rulemaking and NEPA Proceeding, FPL's Subsequent License Renewal Application is Governed by 10 C.F.R. §§ 51.53(c)(2) and 51.45(a).

Absent a new rulemaking and NEPA proceeding to expand the scope of the 1996 GEIS and 2013 Revised GEIS, FPL's subsequent license renewal application must be reviewed under §§ 51.53(c)(2) and 51.45(a), which do not provide for application of Category 1 exclusions.[32] If the NRC wishes to apply the Category 1 exemptions to subsequent license renewal applicants like FPL, it must first revise the 1996 GEIS and rule, and the 2013 Revised GEIS and amended rule, to comply with its own procedural requirements for implementation of NEPA and the Administrative Procedure Act. First, the NRC must issue a scoping notice for a new or revised GEIS, which clearly states the scope of the proposed GEIS and seeks public participation in determining the scope of the analysis and the issues that must be addressed "in depth." 10 C.F.R. §§ 50.28, 50.29(a)(1), and 50.29(a)(2).

Second, the NRC must prepare a draft GEIS and solicit public comment, as required by 10 C.F.R. Part 51. Compliance with these procedural requirements is essential to fulfill NEPA's twin purposes of ensuring sound environmental decisions and allowing the public to play a role in the decision-making process. *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 348–49 (1989).

Finally, the NRC must comply with NEPA and the Administrative Procedure Act by publishing, for public comment, revised NEPA regulations which make the requirements of

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[32] *See* SACE's Hearing Request at 5 and 29.

Table B-1 binding in subsequent license renewal proceedings. *New York v. N.R.C.,* 681 F.3d 471, 476 (D.C. Cir. 2012) (holding that regulations codifying NEPA findings constitute "major federal action" requiring an EIS or environmental assessment); *Union of Concerned Scientists v. N.R.C.,* 711 F.2d 370, 383 (D.C. Cir. 1983) (citing *Pickus v. U.S. Board of Parole,* 507 F.2d 1107, 1113 (D.C. Cir. 1974) (requiring notice-and-comment rulemaking for an NRC decision that "alters a binding norm.").[33]

CONCLUSION

For the foregoing reasons, Petitioners respectfully request that the ALSB determine that § 51.53(c)(3) only applies to pre-1995 applicants for an initial license renewal.

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[33] FPL's argument that the reference in SECY-12-0063 to the potential filing of subsequent license renewal applications overrides the scoping notice and summary report for the 2013 Revised GEIS—which contain no reference whatsoever to the concept of subsequent license renewal or any license renewal term beyond the first twenty years—is inconsistent with NRC regulations and case law. Surreply at 11 n.40. Accuracy in the initial scoping of an EIS is critical because a proposed federal action may not exceed the scope of its supporting EIS. *Duke Power Co.,* 12 N.R.C. at 473 ("In making an evaluation of the environmental impact of a proposed action under NEPA, the scope of the environmental statement or appraisal must be at least as broad as the scope of the action being taken.")). Hence, the NRC must conduct a scoping process "as soon as practicable after publication of the notice of intent" and use it to "[d]efine the proposed action which is to be the subject of the statement or supplement." 10 C.F.R. §§ 51.29(a) and 51.29(a)(1). Public participation is also an important element of the scoping process, and therefore NRC regulations require that a broad range of affected parties, including individuals and organizations, government agencies, and Indian tribes, must be notified and invited to participate. 10 C.F.R. § 51.28. To disregard the content of the scoping notice for the 2013 Revised GEIS or the results of the scoping process would defeat the purpose of these regulations.

Respectfully submitted,

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/

October 1, 2018

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
Florida Power and Light Company	)	Docket Nos. 50-250/251-SLR
Turkey Point Units 3 and 4	)	

CERTIFICATE OF SERVICE

I certify that on October 4, 2018, I posted copies of the foregoing ERRATA TO PETITIONERS' RESPONSE TO APPLICANT'S SURREPLY and PETITIONERS' CORRECTED RESPONSE TO APPLICANT'S SURREPLY on the NRC's Electronic Information Exchange System.

___/signed electronically by/__
Diane Curran
#

LBP-19-3

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:

E. Roy Hawkens, Chairman
Dr. Michael F. Kennedy
Dr. Sue H. Abreu

In the Matter of	Docket Nos. 50-250-SLR & 50-251-SLR
FLORIDA POWER & LIGHT COMPANY	ASLBP No. 18-957-01-SLR-BD01
(Turkey Point Nuclear Generating Units 3 and 4)	March 7, 2019

MEMORANDUM AND ORDER
(Granting the Hearing Requests of SACE and Joint Petitioners, Denying the Hearing Request of Albert Gomez, Granting Monroe County's Request to Participate as an Interested Governmental Participant, and Referring a Ruling to the Commission)

Pending before this Licensing Board are three hearing requests that challenge an application from Florida Power & Light Company (FPL) for a subsequent license renewal (i.e., a second twenty-year license renewal) for two nuclear power reactors, Turkey Point Units 3 and 4, located near Homestead, Florida. The hearing requests were filed by (1) Southern Alliance for Clean Energy (SACE); (2) Friends of the Earth, Inc., Natural Resources Defense Council, Inc., and Miami Waterkeeper, Inc. (collectively, Joint Petitioners); and (3) Albert Gomez. Additionally, Monroe County, Florida filed a request to participate in this proceeding as an interested governmental participant.

For the reasons discussed below, we conclude that (1) SACE has established standing and proffered two admissible contentions; (2) Joint Petitioners have established standing and proffered two admissible contentions; and (3) Mr. Gomez has failed to proffer an admissible contention. We therefore grant SACE's and Joint Petitioners' hearing requests, and we deny

Mr. Gomez's hearing request. We also grant Monroe County's request to participate as an interested governmental participant.

Additionally, pursuant to 10 C.F.R. § 2.323(f)(1), we refer to the Commission our ruling, infra Part III.A, that 10 C.F.R. § 51.53(c)(3) applies to the preparation of environmental reports (ERs) in subsequent license renewal proceedings. See infra note 46.[1]

I. PROCEDURAL BACKGROUND

On January 30, 2018, FPL submitted an application for a subsequent license renewal (SLR) for two nuclear power reactors, Turkey Point Units 3 and 4, located near Homestead, Florida. See Letter from Mano K. Nazar, President and Chief Nuclear Officer, FPL, to Document Control Desk, NRC (Jan. 30, 2018).[2] FPL submitted an ER with its application, as required.[3]

On May 2, 2018, the NRC issued a notice of opportunity to request a hearing and petition for leave to intervene, which provided members of the public sixty days from the date of publication to file a hearing request. See [FPL]; Turkey Point Nuclear Generating, Unit Nos. 3 and 4, 83 Fed. Reg. 19,304 (May 2, 2018). On June 29, 2018, in response to several requests to extend the filing deadline, the Commission granted a thirty-day extension, to and including August 1, 2018. See Commission Order (June 29, 2018) at 2 (unpublished).

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[1] Appended to this Memorandum and Order is an opinion by Judge Abreu dissenting in part (with the majority's interpretation and application of section 51.53(c)(3)) and concurring in part (with those portions of the majority's decision that do not involve the interpretation or application of section 51.53(c)(3)).

[2] See [FPL], Turkey Point Nuclear Plant Units 3 and 4 [SLR] Application (rev. 1 Apr. 2018) [hereinafter SLRA]. The original licenses issued to FPL for Units 3 and 4 authorized forty years of operation, and the first renewal was for an additional twenty years of operation. The current licenses for the units will expire, respectively, on July 19, 2032 and April 10, 2033. Id. at 1-1.

[3] See [FPL] SLRA, App. E, Applicant's Environmental Report, Subsequent Operating License Renewal Stage, Turkey Point Nuclear Plant Units 3 and 4 (Jan. 2018) [hereinafter ER]. The purpose and content of an ER are discussed infra Part III.A.2.

On August 1, 2018, SACE filed a hearing request that proffered two multi-faceted environmental contentions,[4] and Joint Petitioners filed a hearing request that proffered five multi-faceted environmental contentions.[5] On August 2, 2018, Mr. Gomez, acting pro se, submitted a hearing request that proffered ten contentions consisting of safety and environmental challenges to FPL's application.[6]

FPL filed answers opposing all three hearing requests.[7] The NRC Staff filed an answer that (1) did not oppose granting SACE's hearing request and admitting, in part, both of SACE's environmental contentions;[8] and (2) did not oppose Joint Petitioners' hearing request and admitting, in part, two of Joint Petitioners' five environmental contentions.[9] In a separately filed answer, the NRC Staff opposed Mr. Gomez's hearing request.[10]

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4 See [SACE's] Request for Hearing and Petition to Intervene (Aug. 1, 2018) [hereinafter SACE Pet.].

5 See Request for Hearing and Petition to Intervene Submitted by [Joint Petitioners] (Aug. 1, 2018) [hereinafter Joint Pet'rs Pet.].

6 See Proposed Petition to Intervene and for Hearing Under 10 C.F.R. § 2.206, for Docket ID # NRC-2018-0074 (Aug. 2, 2018) [hereinafter Gomez Pet.].

7 See Applicant's Answer Opposing [SACE's] Request for Hearing and Petition to Intervene (Aug. 27, 2018) [hereinafter FPL Answer to SACE Pet.]; Applicant's Answer Opposing Request for Hearing and Petition to Intervene Submitted by [Joint Petitioners] (Aug. 27, 2018) [hereinafter FPL Answer to Joint Pet'rs Pet.]; Applicant's Opposition to Albert Gomez's Petition to Intervene (Sept. 4, 2018) [hereinafter FPL Answer to Gomez Pet.].

8 See NRC Staff's Corrected Response to Petitions to Intervene and Requests for Hearing Filed by (1) [Joint Petitioners], and (2) [SACE] (Aug. 27, 2018) at 57–69 [hereinafter NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet.].

9 See id. at 28–57.

10 See NRC Staff's Response to Petition to Intervene and Request for Hearing Filed by Albert Gomez (Sept. 4, 2018) [hereinafter NRC Staff Answer to Gomez Pet.].

On September 10, 2018, SACE and Joint Petitioners filed replies to FPL's and the NRC Staff's answers.[11] Mr. Gomez did not file a reply.

On September 20, 2018, FPL filed motions to strike certain portions of SACE's and Joint Petitioners' replies, or in the alternative, for leave to file an attached surreply.[12] Although SACE and Joint Petitioners opposed FPL's motions to strike, they did not oppose FPL's motion to file the surreply, and they requested permission to file an attached joint response to it.[13] On October 23, 2018, we (1) denied FPL's motions to strike, but granted its request to file the surreply; (2) granted the request of SACE and Joint Petitioners to file a joint response to FPL's surreply; and (3) authorized the NRC Staff to respond to these pleadings.[14] The NRC Staff filed a response on November 2, 2018.[15]

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[11] See [SACE's] Reply to Oppositions by [FPL] and NRC Staff to SACE's Hearing Request (Sept. 10, 2018) [hereinafter SACE Reply]; Reply in Support of Request for Hearing and Petition to Intervene Submitted by [Joint Petitioners] (Sept. 10, 2018).

[12] See Applicant's Motion to Strike a Portion of the September 10, 2018 Reply Filed by [SACE] or, in the Alternative, for Leave to File a Surreply (Sept. 20, 2018); Applicant's Motion to Strike Portions of the September 10, 2018 Reply Filed by [Joint Petitioners] or, in the Alternative, for Leave to File a Surreply (Sept. 20, 2018); Applicant's Surreply to New Arguments Raised in Reply Pleadings (Sept. 20, 2018) [hereinafter FPL Surreply].

[13] See [SACE]'s Response to [FPL]'s Motion to Strike a Portion of SACE's September 10, 2018, Reply or, in the Alternative for Motion for Leave to File a Surreply (Oct. 1, 2018); [Joint Petitioners'] Answer in Opposition to Applicant's Motion to Strike Portions of the September 10, 2018 Reply Filed by Joint Petitioners or, in the Alternative, for Leave to File a Surreply (Oct. 1, 2018); Motion For Leave to Respond to Applicant's Surreply (Oct. 1, 2018); Petitioners' Response to Applicant's Surreply (Oct. 1, 2018) (corrected Oct. 4, 2018) [hereinafter Pet'rs Response to FPL Surreply].

[14] See Licensing Board Memorandum and Order (Denying FPL's Motion to Strike Portions of Replies, Granting FPL's Request to File a Surreply, Granting SACE and Joint Petitioners' Motion to File Response to Surreply, and Authorizing NRC Staff to File Response) (unpublished) (Oct. 23, 2018).

[15] See NRC Staff's Response to the Applicant's Surreply and the Petitioners' Response, Regarding the Applicability of 10 C.F.R. § 51.53(c)(3) to [SLR] Applications (Nov. 2, 2018) [hereinafter NRC Staff Response to FPL Surreply].

Meanwhile, on September 20, 2018, Monroe County, Florida filed a request to participate as an interested local governmental body pursuant to 10 C.F.R. § 2.315(c), seeking to participate on the two environmental contentions proffered by SACE.[16] The NRC Staff did not oppose Monroe County's participation, provided that the Board admitted the two contentions specified by the County.[17]

On December 4, 2018, this Board held an oral argument in Homestead, Florida to assess SACE's and Joint Petitioners' standing and the admissibility of their proffered contentions. See Official Transcript of Proceedings, [FPL] Turkey Point Units 3 & 4 at 11–259 (Dec. 4, 2018) [hereinafter Tr.].[18] Pursuant to the Board's direction at oral argument, see Tr. at 257, the NRC Staff filed a supplemental brief on December 18, 2018 regarding its position on a contention proffered by SACE and Joint Petitioners,[19] and on January 7, 2019, the other participants filed timely responses. See id. at 258–59.[20]

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[16] See Monroe County, Florida's Request to Participate as Interested Governmental Participant (Sept. 20, 2018) [hereinafter Monroe County Request]. Section 2.315(c) permits a local governmental body that is not admitted as a party under section 2.309 an opportunity to participate in a hearing as an interested non-party.

[17] See NRC Staff's Response to Monroe County, Florida's Request to Participate as an Interested Governmental Entity at 7 (Oct. 1, 2018).

[18] Mr. Gomez's arguments on standing and contention admissibility were submitted on his written pleading. See Tr. at 15; Licensing Board Order (Providing Oral Argument Topics) at 2 n.3 (Nov. 14, 2018) (unpublished).

On December 21, 2018, this Board issued an order granting a joint motion requesting transcript corrections. See Licensing Board Order (Adopting Transcript Corrections) (Dec. 21, 2018) (unpublished).

[19] See NRC Staff's Clarification of its Views Regarding the Admissibility of Joint Petitioners' Contention 1-E and SACE Contention 2 (Alternative Cooling Systems) (Dec. 18, 2018).

[20] See Petitioners' Response to NRC Staff Clarification (Jan. 7, 2019); Applicant's Response to the NRC Staff's Clarification Regarding the Admissibility of Proposed Cooling Tower Contentions (Jan. 7, 2019).

II. LEGAL STANDARDS FOR STANDING AND CONTENTION ADMISSIBILITY

To participate in this proceeding as an intervenor, a petitioner must establish standing and proffer at least one admissible contention. See 10 C.F.R. § 2.309(a). We summarize the applicable legal standards below.

A. LEGAL STANDARDS GOVERNING STANDING

1. Individual Standing and the 50-Mile Proximity Presumption

In determining whether a petitioner has established standing, the Commission applies contemporaneous judicial concepts of standing that require a petitioner to "(1) allege an injury in fact that is (2) fairly traceable to the challenged action and (3) is likely to be redressed by a favorable decision." Fla. Power & Light Co. (Turkey Point Nuclear Generating Plant, Units 3 & 4), CLI-15-25, 82 NRC 389, 394 (2015).[21] However, in the context of certain reactor licensing proceedings (e.g., reactor construction permit proceedings and new reactor operating license proceedings), the Commission has expressly authorized the use of a "proximity presumption," which presumes that a petitioner has standing if he or she resides, or otherwise has frequent contacts, within approximately 50 miles of the facility in question. See PPL Bell Bend, LLC (Bell Bend Nuclear Power Plant), CLI-10-7, 71 NRC 133, 138–39 (2010); Calvert Cliffs 3 Nuclear Project, LLC (Calvert Cliffs Nuclear Power Plant, Unit 3), CLI-09-20, 70 NRC 911, 915–16

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[21] Under section 189a of the Atomic Energy Act, the NRC is required to "grant a hearing upon the request of any person whose interest may be affected by the proceeding." 42 U.S.C. § 2239(a)(1)(A). Pursuant to the agency's regulation implementing general standing requirements, a petitioner's hearing request must state

(i) The name, address and telephone number of the requestor or petitioner;
(ii) The nature of the requestor's/petitioner's right under the [relevant statute] to be made a party to the proceeding;
(iii) The nature and extent of the requestor's/petitioner's property, financial or other interest in the proceeding; and
(iv) The possible effect of any decision or order that may be issued in the proceeding on the requestor's/petitioner's interest.

10 C.F.R. § 2.309(d)(1).

(2009). This presumption "rests on [the] finding . . . that persons living within the roughly 50-mile radius of [a] facility face a realistic threat of harm if a release from the facility of radioactive material were to occur." Calvert Cliffs, CLI-09-20, 70 NRC at 917 (internal quotation marks omitted).

Licensing boards routinely have applied the 50-mile proximity presumption in reactor license renewal proceedings, reasoning that a renewal "allows operation of a reactor over an additional period of time during which the reactor could be subject to the same equipment failures and personnel errors as during operations over the original period of the license." Exelon Generation Co. (Limerick Generating Station, Units 1 & 2), LBP-12-8, 75 NRC 539, 547, rev'd in part on other grounds, CLI-12-19, 76 NRC 377 (2012). The Commission implicitly endorsed this approach when it cited with approval a licensing board's application of the proximity presumption in a reactor license renewal proceeding. See Calvert Cliffs, CLI-09-20, 70 NRC at 915 n.15 (citing Fla. Power & Light Co. (Turkey Point Nuclear Generating Plant, Units 3 & 4), LBP-01-6, 53 NRC 138, 150, aff'd on other grounds, CLI-01-17, 54 NRC 3 (2001)).

We conclude that the 50-mile proximity presumption should apply in all reactor license renewal proceedings, including SLR proceedings. As the Commission explained in Calvert Cliffs, the 50-mile proximity presumption "is simply a shortcut for determining standing in certain cases." Calvert Cliffs, CLI-09-20, 70 NRC at 917. Applying this shortcut to reactor license renewal proceedings not only satisfies contemporaneous judicial concepts of standing, it provides clarity for litigants and licensing boards, thereby promoting efficiency in the adjudicatory process. See, e.g., Entergy Operations, Inc. (River Bend Station, Unit 1), LBP-18-1, 87 NRC 1, 7 n.4 (2018).

2. Representational Standing

An organization that seeks to intervene on behalf of one or more of its members must demonstrate representational standing. To do so, the organization must show that (1) at least one of its members would otherwise have standing to sue in his or her own right; (2) the member has authorized the organization to represent his or her interest; (3) the interests that the organization seeks to protect are germane to its purpose; and (4) neither the claim asserted nor the relief requested requires the member to participate in the adjudicatory proceeding. See Private Fuel Storage, L.L.C. (Indep. Spent Fuel Storage Installation), CLI-99-10, 49 NRC 318, 323 (1999).

B. LEGAL STANDARDS GOVERNING CONTENTION ADMISSIBILITY

A timely-filed contention is admissible if it satisfies the six-factor contention admissibility criteria in 10 C.F.R. § 2.309(f)(1), which requires a petitioner to

> (i) Provide a specific statement of the issue of law or fact to be raised or controverted . . . ;
> (ii) Provide a brief explanation of the basis for the contention;
> (iii) Demonstrate that the issue raised in the contention is within the scope of the proceeding;
> (iv) Demonstrate that the issue raised in the contention is material to the findings the NRC must make to support the action that is involved in the proceeding;
> (v) Provide a concise statement of the alleged facts or expert opinions which support the requestor's/petitioner's position on the issue . . . , together with references to the specific sources and documents on which the requestor/petitioner intends to rely to support its position on the issue; [and]
> (vi) . . . [P]rovide sufficient information to show that a genuine dispute exists with the applicant/licensee on a material issue of law or fact. This information must include references to specific portions of the application . . . that the petitioner disputes and the supporting reasons for each dispute.

10 C.F.R. § 2.309(f)(1)(i)–(vi). Additionally, pursuant to 10 C.F.R. § 2.335, a contention that challenges a Commission rule or regulation will be rejected unless the petitioner makes an appropriate prima facie showing supporting a rule waiver before the licensing board, which then must certify the waiver request to the Commission.

The Commission's contention-admissibility standard is "strict by design," Amergen Energy Co. (Oyster Creek Nuclear Generation Station), CLI-06-24, 64 NRC 111, 118 (2006) (quoting Dominion Nuclear Conn., Inc. (Millstone Nuclear Power Station, Units 2 & 3), CLI-01-24, 54 NRC 349, 358 (2001)), and failure to comply with any admissibility requirement "renders a contention inadmissible." Entergy Nuclear Operations, Inc. (Indian Point, Unit 2), CLI-16-5, 83 NRC 131, 136 (2016).

III. ANALYSIS

Because of its overarching significance to this and other SLR cases, we first examine a legal question relevant to the admissibility of contentions proffered by SACE and Joint Petitioners; namely, whether 10 C.F.R. § 51.53(c)(3) applies to an applicant's preparation of an ER in SLR proceedings. After resolving that issue in the affirmative, infra Part III.A, we then consider whether to grant the hearing requests of SACE, infra Part III.B, Joint Petitioners, infra Part III.C, and Mr. Gomez, infra Part III.D.

A. THE APPLICABILITY OF 10 C.F.R. § 51.53(c)(3) TO THE PREPARATION OF AN ER IN SLR PROCEEDINGS

Petitioners[22] proffer environmental contentions challenging the adequacy of FPL's ER. Before we address the admissibility of these contentions, we consider a legal issue of first impression raised by petitioners, the resolution of which will affect our contention admissibility analysis. Petitioners argue that 10 C.F.R. § 51.53(c)(3)—which provides, inter alia, that applicants for initial license renewals need not consider Category 1 issues in their ER[23]—does not apply to applicants who (like FPL) seek a subsequent license renewal.

To assist the reader in understanding the issue presented, we first discuss the statutory and regulatory scheme governing the NRC Staff's preparation of an environmental impact

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22 When we use the term "petitioners," we are referring collectively to SACE and Joint Petitioners.

23 As explained infra Parts III.A.1 and III.A.2, Category 1 issues are those environmental issues with effects that (1) are generic to all existing nuclear power plants; (2) have been analyzed in the generic environmental impact statement (GEIS) and codified by notice and comment rulemaking in 10 C.F.R. Part 51; (3) are reviewed by the Commission on a 10-year cycle; and (4) need not be addressed by the NRC Staff on a site-specific basis in the draft supplemental environmental impact statement for license renewals.

statement (EIS) incident to its review of applications seeking the renewal of licenses to operate nuclear power plants.[24] We then analyze 10 C.F.R. § 51.53(c)(3) and its applicability to SLRs.

1. Statutory and Regulatory Background Governing the NRC Staff's Preparation of an EIS

In 10 C.F.R. Part 51, the NRC promulgated regulations implementing NEPA requirements. See 10 C.F.R. § 51.10. NEPA requires federal agencies to prepare an EIS for proposed major federal actions "significantly affecting the quality of the human environment," including a detailed discussion of "the environmental impact of the proposed action," "any adverse environmental effects which cannot be avoided should the proposal be implemented," and "alternatives to the proposed action." 42 U.S.C. § 4332(C)(i)–(iii).

NEPA's EIS requirement serves two purposes. "First, it places upon an agency the obligation to consider every significant aspect of the environmental impact of a proposed action." Balt. Gas & Elec. Co. v. Nat'l Res. Def. Council, Inc., 462 U.S. 87, 97 (1983) (quotation marks omitted). "Second, it ensures that the agency will inform the public that it has indeed considered environmental concerns in its decisionmaking process." Id. Although NEPA requires the agency to take a "hard look" at environmental consequences of major federal actions, id., it "seeks to guarantee process, not specific outcomes." Massachusetts v. NRC, 708 F.3d 63, 67 (1st Cir. 2013).

Pursuant to NRC regulations, the renewal of a license to operate a nuclear power plant constitutes a "major Federal action" triggering the NRC's obligation under NEPA to prepare an EIS. See 10 C.F.R. § 51.20(a), (b)(2).

[24] The NRC has codified two sets of regulations governing license renewal applications: (1) 10 C.F.R. Part 54, which focuses on safety-related issues such as equipment aging, see 10 C.F.R. § 54.4 (describing scope of renewal requirements in 10 C.F.R. Part 54); and (2) 10 C.F.R. Part 51, which focuses on the NRC's obligations under the National Environmental Policy Act (NEPA), see id. § 51.10 (explaining the purpose of Part 51 regulations). For purposes of this discussion, we deal only with NEPA and the environmental regulations in Part 51.

Preparing an EIS that considers all of the significant environmental issues relevant to the renewal of a nuclear power plant on a site-specific basis is a demanding and time-consuming task. See Massachusetts v. NRC, 522 F.3d 115, 119 (1st Cir. 2008). In 1991, in anticipation of a wave of applications for initial reactor license renewals, the NRC published a proposed rule[25] and a draft generic environmental impact statement (GEIS)[26] that were designed to inject efficiencies into the agency's environmental review portion of the license renewal process. Both documents embodied the results of a comprehensive study conducted by the NRC to determine those NEPA-related issues that could be addressed generically (that is, issues that applied to all plants) and those that needed to be determined on a plant-by-plant basis. The agency characterized the first group as Category 1 issues and the second as Category 2 issues. See Massachusetts, 522 F.3d at 119; Fla. Power & Light Co. (Turkey Point Nuclear Generating Plant, Units 3 & 4), CLI-01-17, 54 NRC 3, 11 (2001).[27]

In 1996, the NRC issued a final GEIS that analyzed Category 1 issues as to all nuclear power plants,[28] and it codified these findings in 10 C.F.R. Part 51. See Final Rule, Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, 61 Fed. Reg. 28,467 (June 5, 1996) [hereinafter 1996 Final Rule]; 10 C.F.R. pt. 51, subpt. A, app. B (listing

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25 Proposed Rule, Environmental Review for Renewal of Operating Licenses, 56 Fed. Reg. 47,016 (Sept. 17, 1991) [hereinafter 1991 Proposed Rule].

26 Draft [GEIS] for License Renewal of Nuclear Plants, NUREG-1437 (Aug. 1991).

27 For a more comprehensive definition of what constitutes a generic Category 1 issue, see Final Rule, Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, 78 Fed. Reg. 37,282, 37,283–84 n.2 (June 20, 2013) [hereinafter 2013 Final Rule]. The Supreme Court has upheld the NRC's authority to make generic determinations to meet its NEPA obligations. See Balt. Gas & Elec. Co., 462 U.S. at 101 (stating that the generic method is "clearly an appropriate method of conducting the hard look required by NEPA").

28 See Office of Nuclear Regulatory Research, NUREG-1437, [GEIS] for License Renewal of Nuclear Plants at 1-3 to 1-6 (May 1996).

"NEPA issues for license renewal of nuclear power plants" and assigning them to either Category 1 or Category 2); Massachusetts, 522 F.3d at 120.

As the Commission explained in the context of an initial license renewal application proceeding, there are several steps in the NRC Staff's preparation of an EIS. See Turkey Point, CLI-01-17, 54 NRC at 12. First, the Staff prepares a draft supplemental EIS (SEIS), which is a site-specific supplement to the GEIS addressing Category 2 issues, and then the Staff seeks public comments on that draft. See id. The final SEIS adopts all applicable Category 1 environmental impact findings from the GEIS, and it also "takes account of public comments, including plant-specific claims and new information on generic findings. Part 51 requires the final SEIS to weigh all of the expected environmental impacts of license renewal, both those for which there are generic findings and those described in plant-specific analyses." Id. (internal citation omitted).[29]

In sum, the governing regulations establish that for all nuclear plant license renewal applications, the SEIS must include a plant-specific analysis of all Category 2 issues, but that it need not discuss Category 1 issues because those issues have already been addressed

[29] Because Category 1 issues have been addressed and codified in Part 51, "they cannot be litigated in individual adjudications, such as license renewal proceedings for individual plants." Massachusetts, 522 F.3d at 120; see also 10 C.F.R. § 2.335. Instead, the NRC has provided the following avenues for reviewing, changing, or challenging GEIS findings regarding Category 1 issues: (1) the Commission reviews GEIS findings on a ten-year basis to ensure their continuing validity; (2) the NRC Staff can request that the Commission suspend a generic rule or that a particular adjudication be delayed until the GEIS and accompanying rule are amended; (3) the NRC Staff can request that a generic rule be suspended with respect to a particular plant; (4) a party to an adjudicatory proceeding can invoke 10 C.F.R. § 2.335 and request that an NRC rule (i.e., a GEIS finding for a Category 1 issue) be waived with respect to that proceeding; and (5) any member of the public can petition the agency for a rulemaking proceeding for the purpose of changing the GEIS findings. See Massachusetts, 522 F.3d at 120–21; Turkey Point, CLI-01-17, 54 NRC at 12, 23 n.14.

Category 2 issues, unlike Category 1 issues, can be litigated in NRC adjudicatory proceedings. As the United States Court of Appeals for the First Circuit stated, this "divergent treatment of generic and site-specific issues is reasonable and consistent with the purpose of promoting efficiency in handling license renewal decisions." Massachusetts, 522 F.3d at 120.

globally in the GEIS and codified in 10 C.F.R. Part 51. See 10 C.F.R. pt. 51, subpt. A, app. B; id. §§ 51.71(d), 51.95(c)(4). "When the GEIS and SEIS are combined, they cover all issues that NEPA requires be addressed in an EIS for a nuclear power plant license renewal proceeding." Massachusetts, 522 F.3d at 120.[30]

2. The Applicability of 10 C.F.R. § 51.53(c)(3) to SLR Proceedings

Although preparing an EIS that complies with NEPA is ultimately the NRC's responsibility, the process of creating an EIS begins with the license renewal applicant. See Massachusetts, 522 F.3d at 120. Pursuant to 10 C.F.R. §§ 51.45 and 51.53(c)(1), license renewal applicants must submit an ER, the purpose of which is "to aid the Commission in complying with section 102(2) of NEPA." 10 C.F.R. § 51.14.[31] The NRC Staff, in turn, reviews the ER and "draw[s] upon [it] to produce a draft [SEIS]." Massachusetts, 522 F.3d at 120.

As previously mentioned, this case raises the question of Commission intent regarding the scope of section 51.53(c)(3); more specifically, this case requires us to determine whether section 51.53(c)(3) may be construed as applying to an SLR applicant. The regulation states in pertinent part:

> (c) *Operating license renewal stage.* (1) Each applicant for renewal of a license to operate a nuclear power plant under part 54 of this chapter shall submit with its application a separate document entitled "Applicant's Environmental Report—Operating License Renewal Stage."
>
> (2) . . . This report must describe in detail the affected environment around the plant, the modifications directly affecting the environment or any plant

[30] SACE makes a passing argument in its brief that the NRC Staff may not rely on the GEIS for addressing Category 1 issues in preparing a draft EIS for SLR applications. See Pet'rs Response to FPL Surreply at 16; see also Tr. at 24. We disagree. Such an argument flies in the face of the 1996 regulatory language and structure, see 10 C.F.R. §§ 51.71(d), 51.95(c)(4); infra note 35 and accompanying text, as well as the plain language of the 2013 GEIS, which is a progeny of the 1996 regulations and which states that "[f]or [Category 1 issues] . . . no additional plant-specific analysis is required in future . . . SEISs unless new and significant information is identified." Office of Nuclear Reactor Regulation, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437, at 4-3 (Vol. 1, Rev. 1 June 2013) [hereinafter 2013 GEIS].

[31] Accord 10 C.F.R. § 51.41; see also id. § 51.45(c) ("The [ER] should contain sufficient data to aid the Commission in its development of an independent analysis [in the EIS].").

effluents, and any planned refurbishment activities. In addition, the applicant shall discuss in this report the environmental impacts of alternatives and any other matters described in § 51.45. . . .

(3) For those applicants seeking an initial renewed license and holding an operating license . . . as of June 30, 1995, the environmental report shall include the information required in paragraph (c)(2) of this section subject to the following conditions and considerations:

(i) The environmental report for the operating license renewal stage is not required to contain analyses of the environmental impacts of the license renewal issues identified as Category 1 issues in Appendix B to subpart A of this part.

(ii) The environmental report must contain analyses of the environmental impacts of the proposed action, including the impacts of refurbishment activities, if any, associated with license renewal and the impacts of operation during the renewal term, for those issues identified as Category 2 issues in Appendix B to subpart A of this part. . . .

* * *

(iii) The report must contain a consideration of alternatives for reducing adverse impacts, as required by § 51.45(c), for all Category 2 license renewal issues in Appendix B to subpart A of this part. No such consideration is required for Category 1 issues in Appendix B to subpart A of this part.

(iv) The environmental report must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.

10 C.F.R. § 51.53(c) (emphasis added).

Section 51.53(c)(3) thus identifies a particular category of license renewal applicants (i.e., those seeking "an initial renewed license"), and it states that their ERs shall include the information required in section 51.53(c)(2) subject to certain "conditions and considerations," including the following: (1) the ER need not contain analyses of generic Category 1 issues but, instead, may reference and adopt the Commission's generic findings in 10 C.F.R. Part 51 and the GEIS, id. § 51.53(c)(3)(i); (2) the ER must provide a site-specific review of the non-generic Category 2 issues, id. § 51.53(c)(3)(ii); and (3) the ER must address any new and significant information regarding environmental impacts, of which the applicant is aware, that might render the Commission's generic Category 1 determinations incorrect in that proceeding. Id. § 51.53(c)(3)(iv); see also Turkey Point, CLI-01-17, 54 NRC at 3, 11.

In considering petitioners' assertion that section 51.53(c)(3) does not apply to SLRs, our starting point is the regulatory language. See Ne. Nuclear Energy Co. (Millstone Nuclear Power Station, Unit 3), CLI-01-10, 53 NRC 353, 361 (2001) ("[Regulatory] interpretation begins with the language and structure of the provision itself."). Although section 51.53(c)(3) directs applicants seeking an initial renewed license to prepare ERs in accordance with certain regulatory prescriptions, it (1) is silent as to SLR applicants; and (2) imposes no restrictions on the Commission's authority to allow SLR applicants to utilize these regulatory prescriptions when preparing ERs. Restated, the plain regulatory language does not answer the question presented, because it neither directs the Commission to apply section 51.53(c)(3) to SLR applicants, nor does it forbid the Commission from doing so. Given this regulatory silence, we must look beyond the plain language to discern the Commission's intent.

In our effort to ascertain Commission intent, we are guided by the Supreme Court's approach in Fed. Express Corp. v. Holowecki, 552 U.S. 389 (2008), where, in limning the scope of a regulatory provision in the face of regulatory silence, the Court conducted a holistic analysis that considered (1) the regulatory structure; (2) the agency's interpretative rules; and (3) administrative efficiency, logic, and practicality. In our judgment, a holistic analysis of section 51.53(c)(3) counsels emphatically against the restrictive interpretation urged by petitioners, and reveals, instead, that the Commission intended section 51.53(c)(3) to apply to all license renewal applications, including SLRs. Cf. Christensen v. Harris Cty., 529 U.S. 576, 583–88 (2000) (rejecting petitioners' invitation to put a restrictive gloss on a silent statutory provision when that gloss is not supported by the statutory or regulatory scheme).[32]

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[32] In Shook v. D.C. Fin. Responsibility and Mgmt. Assistance Auth., 132 F.3d 775, 782 (D.C. Cir. 1998), the court of appeals recognized that "[s]ometimes Congress drafts statutory provisions that appear preclusive of other unmentioned possibilities . . . without meaning to exclude the unmentioned ones." Agencies are likewise susceptible of such drafting imprecision, and in such circumstances, a tribunal is obliged to give effect to agency intent in a manner that comports with the regulatory text, purpose, and structure.

At the outset, we observe that the regulatory history accompanying the 1991 proposed rule stated that the rule was intended to apply "to one renewal of the initial license for up to 20 years beyond the expiration of the initial license." See 1991 Proposed Rule, 56 Fed. Reg. at 47,017. Significantly, however, the proposed rule itself did not include the above restrictive phrase, and when the final rule was issued in 1996, neither it nor its regulatory history included this phrase. See 1996 Final Rule, 61 Fed. Reg. at 28,467. The omission of this phrase supports a conclusion that the Commission did not intend to limit section 51.53(c)(3) to initial license renewals. See Tr. at 62. This conclusion is buttressed by the regulatory structure, including Appendix B to Subpart A of Part 51—to which section 51.53(c)(3)(ii) refers and that codifies the GEIS's findings—that does not refer to "initial" renewals, but speaks more broadly about applying to "a renewed operating license for a nuclear power plant," and as "represent[ing] the analysis of the environmental impacts associated with renewal of any operating license . . . ." 10 C.F.R. pt. 51, subpt. A, app. B.[33]

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[33] As discussed supra Part III.A.1, a singular purpose of the rule was to promote efficiency in the license renewal process for the wave of initial license renewal applications that was expected to arrive shortly after the rule's promulgation in 1996. FPL and the NRC Staff state that the NRC was, quite understandably, then focused on initial license renewals. See FPL Surreply at 5–6; Tr. at 37. In FPL's view, the word "initial" in section 51.53(c)(3) is properly viewed as a non-restrictive reference to the category of renewals the agency was then contemplating. See FPL Surreply at 6; Tr. at 38. They argue that this non-restrictive reference—although still operative—does not perforce indicate a Commission intent to limit section 51.53(c)(3) to initial license renewals. We agree.

Despite numerous regulatory revisions to section 51.53 since its initial issuance, we found nothing in the regulatory history indicating that the scope of section 51.53(c)(3)—in 1996 or thereafter—was intended to be restricted to initial license renewals, nor do petitioners identify any such history. See Final Rule, Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, 61 Fed Reg. 66,537 (Dec. 18, 1996) (making minor clarifying and conforming changes and adding language to Table B-1 that had been omitted); Final Rule, Licenses, Certifications, and Approvals for Nuclear Power Plants, 72 Fed. Reg. 49,352 (Aug. 28, 2007) (modifying section 51.53(c)(3) to clarify its applicability to combined license applications); 2013 Final Rule, 78 Fed. Reg. at 37,282 ("[R]edefin[ing] the number and scope of the environmental impact issues that must be addressed by the NRC and applicants during license renewal environmental reviews"); Final Rule, Continued Storage of Spent Nuclear Fuel, 79 Fed. Reg. 56,238, 56,253 (Sept. 19, 2014) (amending section 51.53 "to improve readability and to clarify how the generic determination will be used in future NEPA documents for power

That the Commission did not intend to restrict section 51.53(c)(3) to initial license renewals is also consistent with an explicitly stated regulatory purpose, which is to promote efficiency in the environmental review process for license renewal applications.[34] Accepting petitioners' argument would result in an environmental review process where SLR applicants would be required to analyze Category 1 issues on a plant-specific basis, despite the fact that these generic issues have already been analyzed in the GEIS and codified in Appendix B to Subpart A of Part 51. In other words, accepting petitioners' cabined interpretation of section 51.53(c)(3) would compel SLR applicants to perform a time-consuming and unnecessary act, in derogation of the regulatory purpose. This we are unwilling to do. See Exxon Nuclear Co. (Nuclear Fuel Recovery and Recycling Center), ALAB-447, 6 NRC 873, 878 (1977) ("It is an elementary canon of construction that we 'cannot interpret federal statutes to negate their own stated purposes.'") (quoting N.Y. Dep't of Social Servs. v. Dublino, 413 U.S. 405, 419–20 (1973)).

Accepting petitioners' restricted interpretation of section 51.53(c)(3) is also incompatible with the purpose of an ER, which is designed to aid the NRC Staff in preparing a draft SEIS. See supra note 31. When the NRC Staff prepares a draft SEIS, unambiguous regulations require it to apply the GEIS to Category 1 issues.[35] Because an ER is "essentially the

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reactors and ISFSIs"); Final Rule, Miscellaneous Corrections, 79 Fed. Reg. 66,598, 66,599 (Nov. 10, 2014) (correcting typographical errors in section 51.53(d)).

[34] See 1996 Final Rule, 61 Fed. Reg. at 28,467 (explaining that the Commission's intent behind 10 C.F.R. Part 51 is to "improve the efficiency of the process of environmental review for applicants seeking to renew an operating license").

[35] See 10 C.F.R. § 51.95(c)(4) (stating that the SEIS prepared by the NRC incident to the renewal of an operating license "shall integrate the conclusions in the [GEIS] for issues designated as Category 1 with information developed for those Category 2 issues applicable to the plant"); id. § 51.71(d) (stating that the draft SEIS "for license renewal prepared under § 51.95(c) will rely on conclusions as amplified by the supporting information in the GEIS for issues designated as Category 1 in appendix B to subpart A of this part"); id. pt. 51, subpt. A, app. B (identifying Category 1 issues applicable to "license renewal of nuclear power plants").

applicant's proposal" for the NRC Staff's supplemental SEIS,[36] it logically follows that an SLR applicant should, like an applicant for an initial renewal, prepare an ER in accordance with section 51.53(c)(3) and, accordingly, apply the GEIS to Category 1 issues rather than analyzing them on a plant-specific basis. Otherwise, its ER would contain an overwhelming amount of information that would be of no assistance to the NRC Staff in its preparation of the draft SEIS. Absent persuasive indicators to the contrary, we are unwilling to impute to the Commission an intent to have an SLR applicant prepare an ER that does not serve its regulatory purpose.

Accepting petitioners' argument would not only undermine the regulatory purpose, it would ignore an express regulatory mandate in section 51.95(c)(4). In license renewal proceedings, the NRC Staff is required to integrate into the draft SEIS "information developed for those Category 2 issues applicable to the plant under § 51.53(c)(3)(ii)." 10 C.F.R. § 51.95(c)(4) (emphasis added). In other words, section 51.95(c)(4), which applies broadly to all license renewal proceedings, see supra note 35, commands the NRC to consider the "information developed" by an SLR applicant "under § 51.53(c)(3)(ii)" in its preparation of the draft SEIS. In our view, this regulatory command is persuasive evidence that, contrary to petitioners' argument, the Commission did not intend to restrict section 51.53(c)(3) to initial license renewal applicants.

This conclusion is strengthened by the fact that Part 51 requires periodic reviews of the GEIS findings to ensure that the environmental analyses for Category 1 issues remain current. The regulation states in pertinent part: "On a 10-year cycle, the Commission intends to review the material in [Appendix B] and update it if necessary. A scoping notice must be published in the Federal Register indicating the results of the NRC's review and inviting public comments and proposals for other areas that should be updated." 10 C.F.R. pt. 51, subpt. A, app. B. This

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36 See Final Rule, Rules of Practice for Domestic Licensing Proceedings—Procedural Changes in the Hearing Process, 54 Fed. Reg. 33,168, 33,172 (Aug. 11, 1989).

regulatory requirement for periodic reviews and updates of the GEIS would not be necessary unless the Commission contemplated that the NRC Staff, as well as all license renewal applicants, could rely on the generic findings in the GEIS instead of engaging in the wholly unnecessary process of considering Category 1 issues on a site-specific basis.

The most recent update of the GEIS occurred in June 2013. See 2013 GEIS.[37] The following extract from the final regulatory analysis for that update expressly considered SLR applications in its cost-benefit analysis, signifying that the Commission intended the 2013 GEIS and Appendix B to apply to SLRs:

> Some plants will become eligible for a second 20-year license extension after [fiscal year (FY)] 2013. While the NRC understands that the possibility exists for license holders to submit a second license renewal application, no letters of intent have been received as of the issuance date of this document. The NRC estimates receiving 3 applications per year from FY 2015 through FY 2022. The NRC estimates that a total of 30 license renewal applications (including applications for a second license renewal) will be received in the 10-year cycle following the effective date of the rule.

See SECY-12-0063, Final Rule: Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, encl. 2 at 25 (Apr. 20, 2012).[38] Nowhere in the regulatory

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[37] Notably, the NRC's scoping report for the 2013 update to the GEIS stated that "[t]he NRC's current plan is to apply the revised GEIS to all license renewal applications submitted after the date [of] the Record of Decision for the revised GEIS is printed in the Federal Register." [EIS] Scoping Process Summary Report, Update of the [GEIS] for License Renewal of Nuclear Plants at 67 (May 2009) (emphasis added). This scoping summary report was referenced in the proposed rule to update Part 51. See Proposed Rule, Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, 74 Fed. Reg. 38,117, 38,119 (July 31, 2009) (describing the scoping process). For a full description of the reasons public comments were sought, see Notice of Intent to Prepare an [EIS] for the License Renewal of Nuclear Power Plants and to Conduct Scoping Process, 68 Fed. Reg. 33,209, 33,210 (June 3, 2003).

[38] We acknowledge that this SECY paper (which is a formal memorandum to the Commissioners from the Executive Director for Operations that seeks Commission approval for the specified Staff action) "lack[s] the force of law" and, accordingly, cannot serve to alter a regulation. Christensen, 529 U.S. at 587. Here, however, we seek to discern Commission intent regarding the scope of a silent regulation. In our judgment, this SECY paper, which was the basis for Commission action on the final rule, see SRM-SECY-12-0063, Final Rule: Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses

history of the 2013 rulemaking (or, for that matter, in any of the post-1996 rulemakings, see supra note 33), was there any discussion of an intent to restrict the application of section 51.53(c)(3) to initial license renewals. Rather, it discussed license renewals in general, without differentiating between initial renewals and SLRs, giving rise to a persuasive inference that the Commission intended the updated GEIS—and therefore section 51.53(c)(3)—to apply to all applicants.

After completion of the 2013 rulemaking, the NRC Staff informed the Commission that, with regard to SLR applications, "[t]he staff does not recommend updating the environmental regulatory framework under 10 CFR Part 51 . . . , because environmental issues can be adequately addressed by the existing GEIS and through future GEIS revisions." SECY-14-0016, Ongoing Staff Activities to Assess Regulatory Considerations for Power Reactor [SLR], at 5 (Jan. 31, 2014). The Commission accepted that recommendation, which is further evidence of the Commission's intention to apply the 2013 GEIS and Appendix B—and, hence, section 51.53(c)(3)—to SLR applicants. See SRM-SECY-14-0016, Ongoing Staff Activities to Assess Regulatory Considerations for Power Reactor [SLR] (Aug. 29, 2014) (disapproving the NRC Staff's recommendation to initiate a rulemaking pursuant to Part 54, but refraining—consistent with the NRC Staff's recommendation—from updating the Part 51 regulatory framework for SLR applications).

(Dec. 6, 2012), provides insight into the Commission's view regarding the continuing applicability of the GEIS to license renewals and, hence, the applicability of section 51.53(c)(3) to SLR applications. In other words, as we have shown, when the regulations were issued in 1996, the regulatory purpose and structure reveal that the Commission did not intend section 51.53(c)(3) to be restrictive in its scope, and that intent has remained constant with the passage of time.

The 2013 GEIS itself discusses license renewals in general and non-restrictive terms, from which it may be inferred that SLR applicants may rely on the GEIS and Appendix B and, accordingly, need not consider Category 1 issues on a site-specific basis in their ER.[39]

Petitioners nevertheless assert that the agency intended the 1996 GEIS and the 2013 GEIS to be limited to initial license renewals. See Pet's Response to FPL Surreply at 5–8. But petitioners fail to identify any provision in the 1996 GEIS that compels us to accept their argument. And regarding the 2013 GEIS, petitioners' argument fails to account for the following language in the GEIS: (1) the "purpose and need for the proposed action (issuance of a renewed license) is to provide an option [to continue plant operations] beyond the term of the current . . . operating license," 2013 GEIS at 1-3; (2) the "decisions to be [] supported by the GEIS are whether or not to renew the operating licenses of . . . power plants for an additional 20 years," id. at 1-7; and (3) "[t]here are no specific limitations in the Atomic Energy Act or the NRC's regulations restricting the number of times a license may be renewed." Id. at S-1. The 2013 GEIS clearly indicates that it assesses "environmental consequences of renewing the licenses . . . and operating the plants for an additional 20 years beyond the current license term." Id. at S-4 (emphasis added). Additionally, the 2013 GEIS states that the proposed action

39 See, e.g., 2013 GEIS at 1-4 ("The GEIS serves to facilitate NRC's environmental review process by identifying and evaluating environmental impacts that are considered generic and common to all nuclear power plants. . . . Generic impacts will be reconsidered in SEISs only if there is new and significant information that would change the conclusions in the GEIS."); id. at 1-7 to1-8 ("The decisions to be [] supported by the GEIS are whether or not to renew the operating licenses of individual commercial nuclear power plants for an additional 20 years. The GEIS was developed to support these decisions and to serve as a basis from which future NEPA analyses for the license renewal of individual nuclear power plants would tier."); id. at 1-8 ("The GEIS provides the NRC decision-maker with important environmental information considered common to all nuclear power plants and allows greater focus to be placed on plant-specific (i.e., Category 2) issues."); id. at 1-17 ("The applicant is not required to assess the environmental impacts of Category 1 issues listed in Table B-1 unless the applicant is aware of new and significant information that would change the conclusions in the GEIS."); id. at 4-3 ("For [Category 1 issues], no additional plant-specific analysis is required in future supplemental EISs . . . unless new and significant information is identified.").

includes the activities associated with the "license renewal term," id. at 4-2, and this term is used throughout the GEIS in assessing the impacts of these activities, as well as in various impact findings codified in Table B-1. The 2013 GEIS defines the "license renewal term" as "[t]hat period of time past the original or current license term for which the renewed license is in force." Id. at 7-27 (emphasis added).

In short, the 2013 GEIS—which is an express regulatory product of the 1996 regulations—explicitly purports to assess the environmental impacts associated with a 20-year renewal period, regardless of whether this period follows the original license or a current renewed license. And the 2013 revisions to the Part 51 rules codify in Table B-1 the findings from the 2013 GEIS on the impacts associated with the "license renewal term."[40]

In our judgment, the Part 51 regulatory structure—commencing with the proposed 1991 regulations, and continuing to present (including the 2013 GEIS)—is compelling evidence that the Commission intended for all license renewal applicants to comply with the requirements of 10 C.F.R. § 51.53(c)(3) when preparing an ER. More specifically, consistent with section 51.53(c)(3), an SLR applicant "is not required to assess the environmental impacts of Category 1 issues listed in Table B-1 unless the applicant is aware of new and significant information that would change the conclusions in the GEIS." 2013 GEIS at 1-17.

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[40] Despite the above regulatory language, petitioners argue that the 2013 GEIS should not apply to SLRs because it fails to adequately consider the environmental impacts associated with SLRs (i.e., with a plant life of 80 years) for, e.g., occupational radiation exposures, public radiation doses, and decommissioning. See Pet'rs Response to FPL Surreply at 7–8. In light of our conclusion above that the 2013 GEIS aims to assess the environmental impacts associated with SLRs, and because Part 51 commands the NRC Staff to use the GEIS in preparing the SEIS for a license renewal, see supra note 35, we summarily reject petitioners' argument, concluding that it is essentially an impermissible attempt to challenge Category 1 findings in an adjudicatory proceeding without having first sought a waiver. See 10 C.F.R. § 2.335(a).

NRC guidance documents support this conclusion.[41] For example, NRC Regulatory Guide 4.2 provides instructions for license renewal applicants for the "preparation of [ERs] that are submitted as part of an application for the renewal of a nuclear power plant operating license in accordance with [10 C.F.R. Part 54]." Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications, Regulatory Guide 4.2, at 1 (supp. 1, rev. 1 June 2013) [hereinafter Reg. Guide 4.2]. This Regulatory Guide does not distinguish between initial and subsequent license renewal applicants; rather, because it repeatedly refers broadly to "applicants" and "license renewal applicants," it is reasonably construed as applying to both categories of applicants. See, e.g., Reg. Guide 4.2 at 1, 5, 6, 7, 8, 10.[42]

Moreover, and most significantly, Reg. Guide 4.2 repeatedly states that issues "identified as Category 1 issues in the GEIS, are adequately addressed for all applicable nuclear plants. The NRC will not require additional analysis in plant-specific [ERs] unless new and significant information has been identified . . . The applicant may adopt the findings in the GEIS for Category 1 issues if no new and significant information is discovered." Id. at 25 (emphasis added); see also id. at 2, 7.

According "special weight" to Reg. Guide 4.2 as directed by the Commission, Indian Point, CLI-15-6, 81 NRC at 356, and recognizing that it "reflect[s] a body of experience and informed judgment" developed by the NRC Staff, Holowecki, 522 U.S. at 399, we find that it

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41 The Supreme Court has stated that an agency's interpretative statements "reflect a body of experience and informed judgment to which courts and litigants may properly resort for guidance. As such, they are entitled to a measure of respect . . . ." Holowecki, 552 U.S. at 399 (internal citations omitted); see also Entergy Nuclear Operations, Inc. (Indian Point, Units 2 & 3), CLI-15-6, 81 NRC 340, 356 (2015) ("Guidance documents that are developed to assist in compliance with applicable regulations are . . . entitled to special weight.") (internal citation omitted).

42 Accord Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Operating License Renewal, NUREG-1555, at iii (supp. 1, rev. 1, June 2013) (providing instructions for NRC Staff in "conducting an environmental review for the renewal of a nuclear power plant operating license") (emphasis added).

provides strong support for concluding that "[a]pplicants for renewal of power reactor operating licenses," including SLR applicants, may "use the guidance in [Reg. Guide 4.2] to develop the [ER] required under 10 C.F.R. 51.53(c)." Reg. Guide 4.2 at 56. Accordingly, SLR applicants need "not [conduct] additional analysis in . . . [ERs for Category 1 issues] unless new and significant information is identified." Id. at 25.[43]

A contrary conclusion—in addition to being discordant with the regulatory purpose, regulatory structure, and Reg. Guide 4.2—would result in the following untenable interplay between the NRC's environmental review procedures in 10 C.F.R. Part 51 and its adjudicatory procedures in 10 C.F.R. Part 2. First, assume that we accept petitioners' argument that section 51.53(c)(3) does not apply to SLRs and, accordingly, that we admit a contention alleging that FPL's ER is deficient because it fails to consider a Category 1 issue on a plant-specific basis. Further, assume that thereafter the NRC Staff issues a draft SEIS that, consistent with regulatory requirements, likewise does not consider that Category 1 issue on a plant-specific basis. Pursuant to the agency's contention-migration tenet,[44] the admitted contention would become a challenge to the NRC Staff's draft SEIS. Because the NRC Staff's non-consideration of the Category 1 issue on a plant-specific basis fully comports with its environmental review responsibilities under NEPA and Part 51, see Balt. Gas & Elec. Co., 462 U.S. at 101; supra note 35 and accompanying text, the contention would be subject to summary dismissal on the

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[43] The Supreme Court has instructed that in assessing the deference to be accorded to an interpretative rule, a tribunal should "consider whether the agency has applied its position with consistency." Holowecki, 552 U.S. at 399–400. The current version of Reg. Guide 4.2 has been applied by the agency and relied upon by the nuclear industry for over five years. Plainly, FPL relied upon it when preparing this ER, see ER at 1-7, and FPL's reliance was consistent with the agency's expectation embodied in NUREG-1555. See supra note 42.

[44] "[A] contention 'migrates' when a licensing board construes a contention challenging [an ER] as a challenge to a subsequently issued Staff NEPA document without the petitioner amending the contention." Crow Butte Res., Inc. (In Situ Leach Facility, Crawford, Neb.), CLI-15-17, 82 NRC 33, 42 n.58 (2015).

alternative grounds that it was (1) outside the scope of the proceeding, see 10 C.F.R. § 2.309(f)(1)(iii); or (2) an impermissible challenge to an agency regulation. See id. § 2.335(a). We do not believe that the Commission intended to craft a regulatory scheme that would require litigants and licensing boards to engage in a senseless adjudicatory process that, in practice, would result in the wasteful expenditure of private and governmental resources in derogation of the public interest. We therefore decline to credit petitioners' interpretation of section 51.53(c)(3), which would compel this absurd result.[45]

In sum, based on a holistic review of 10 C.F.R. § 51.53(c)(3) that considers (1) regulatory language and structure; (2) regulatory purpose and history; (3) interpretative rules; and (4) efficiency, logic, and practicality, we are persuaded that the Commission did not intend to restrict section 51.53(c)(3) to initial license renewals. Accordingly, we conclude that FPL's ER need not consider generic Category 1 issues on a site-specific basis but, instead, may rely on the Category 1 findings in the GEIS and Table B-1, and we will assess petitioners' contentions in that light.[46]

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45 Cf. Griffin v. Oceanic Contractors, Inc., 458 U.S. 564, 575 (1982) ("It is true that interpretations of a statute which would produce absurd results are to be avoided if alternative interpretations consistent with the legislative purpose are available.").

46 Given the significance of this legal issue of first impression, we will refer our ruling on this matter to the Commission pursuant to 10 C.F.R. § 2.323(f)(1). We note that this issue is pending before a licensing board in another SLR proceeding, signifying that it will likely be a recurring issue until resolved by the Commission. See Beyond Nuclear, Inc.'s Hearing Request and Petition to Intervene, Exelon Generation Co. (Peach Bottom Atomic Power Station, Units 2 & 3), Nos. 50-277/278-SLR (Nov. 19, 2018).

3. A Response to the Dissent

The dissent would lead this Licensing Board to an irrational result based on its conviction that section 51.53(c)(3), by its plain and (allegedly) unambiguous language, excludes SLRs and necessarily applies only to initial license renewals. See Dissent at 1–3, 18. With respect, the dissent is incorrect.[47]

To support its restrictive reading of section 51.53(c)(3), the dissent cites the canon of statutory interpretation expressio unius est exclusio alterius, see Dissent at 3, which means "the mention of one thing implies the exclusion of another." Shook, 132 F.3d at 782. The dissent views the Commission's use of the word "initial" as necessarily precluding SLRs. See Dissent at 4 ("Something is either 'initial,' . . . or it is not. No room exists for anything else.").

However, the expressio unius canon is not an inflexible rule of law commanding that the mere mention of one thing means the exclusion of another; rather, it is "used as a starting point in [regulatory] construction" to ascertain the intent of the drafter. Shook, 132 F.3d at 782. The force of the canon in a particular case, like "[t]he force of any negative implication, . . . depends on context." NLRB v. Sw. Gen., Inc., __ U.S. __, __, 137 S. Ct. 929, 940 (2017) (internal quotations omitted). Thus, whether the word "initial" in section 51.53(c)(3) necessarily excludes SLRs from the regulation's scope is a matter of Commission intent, to be determined by considering "whether or not the [Commission's] mention of one thing . . . does really necessarily, or at least reasonably, imply the preclusion of alternatives." Shook, 132 F.3d at 782; accord Sw. Gen., Inc., __ U.S. at __, 137 S. Ct. at 940 (applying expressio unius "only when circumstances support [] a sensible inference that the term left out must have been meant to be excluded") (internal citation omitted). Our review of the circumstances surrounding the proposal and

47 To be clear, we agree with the dissent's statement that, pursuant to its plain language, section 51.53(c)(3) applies to applicants seeking an "initial renewed license." Dissent at 2. Our interpretation of section 51.53(c)(3) gives full (but not preclusive) effect to this phrase.

issuance of the Part 51 regulatory amendments, see supra Part III.A.2, reveals that the mention of initial license renewals in section 51.53(c)(3) does not support a reasonable inference (much less a necessary one) that the Commission intended to exclude SLRs.[48]

Significantly, the dissent does not dispute that its restrictive reading of section 51.53(c)(3) places that regulation in irreconcilable tension with "sections 51.71(d), 51.95(c), and 10 C.F.R. Part 51, Subpart A, Appendix B," Dissent at 8, which all refer broadly to "license renewals" rather than restrictively to "initial" license renewals. To harmonize its interpretation with these other portions of Part 51 in light of the 1991 regulatory history, the dissent suggests (but "do[es] not advocate", id. at 9 n.38) that "the word 'initial' would need to be read into [these regulatory provisions]." Id. at 8. That the dissent's interpretation would result in the de facto revision of three regulations powerfully illustrates the infirmity of its analysis. Such a wholesale adjudicatory revision to the Part 51 regulatory structure in derogation of Commission intent is both unsupportable and impermissible.[49]

According to the dissent, the fact that Part 51 provides for periodic updates of the GEIS does not mean that an SLR applicant can rely on the GEIS to prepare its ER; rather, "it simply means that when the GEIS is used [by the NRC Staff to prepare an SEIS,] the information it contains is reasonably up-to-date." Dissent at 7 n.32. In our view, however, it is nonsensical—indeed, absurd—to conclude that Part 51 authorizes the NRC Staff to rely on the GEIS when

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48 The dissent's analysis relies significantly on the snippet of regulatory history in the 1991 proposed rule that stated the rule would apply "to one renewal of the initial license for up to 20 years beyond [its] expiration." Dissent at 4. However, this phrase was omitted from the regulatory history in the 1996 final rule—and with good reason. It did not comport with the regulatory purpose and structure, both of which supported a conclusion that the Commission did not intend to restrict section 51.53(c)(3) to initial license renewals. See supra Part III.A.2.

49 In addition to suggesting an extensive regulatory revision in the guise of interpreting section 51.53(c)(3), the dissent proposes a "short-term [procedural] solution" for SLR applicants and the NRC Staff to follow in conducting their Part 51 environmental review. See Dissent at 16. This "short-term [procedural] solution," however, would also constitute an impermissible adjudicatory revision of Part 51 in derogation of Commission intent.

preparing an SEIS, but prohibits an SLR applicant from doing so when preparing an ER. After all, in light of the periodic update of the GEIS, now, as in 1996, "[w]hen the GEIS and SEIS are combined, they cover all issues that NEPA requires be addressed in an EIS for a nuclear power plant license renewal proceeding." Massachusetts, 522 F.3d at 120. Moreover, because (as we have shown) the Commission did not intend to exclude SLR applicants from using section 51.53(c)(3) in the preparation of ERs, it necessarily follows that the Commission did not intend to preclude SLR applicants from relying on the updated GEIS in the preparation of ERs. The updated GEIS (including its codification and regulatory history) as well as the agency's interpretative rules support this conclusion.

Notably, if there were any question in 1991 and 1996 about whether updated GEIS findings, as codified in Part 51, could validly be applied to SLRs, an affirmative answer could be gleaned from the following discussion in the regulatory history:

> (1) License renewal will involve nuclear power plants for which the environmental impacts of operation are well understood as a result of data evaluated from operating experience to date; (2) activities and requirements associated with license renewal are anticipated to be within this range of operating experience, thus environmental impacts can reasonably be predicted; and (3) changes in the environment around nuclear power plants are generally gradual and predictable with respect to characteristics important to environmental impact analyses.

1991 Proposed Rule, 56 Fed. Reg. at 47,016 (emphasis added); accord 1996 Final Rule, 61 Fed. Reg. at 28,467–68. The above principles, which explain the creation of Category 1 issues and justify their use in ERs and SEISs, apply with equal force to initial license renewals and SLRs. The dissent's contrary view is not tenable.

The dissent also expresses concern that our interpretation of section 51.53(c)(3) runs afoul of the Administrative Procedure Act (APA) by (1) effecting a de facto change to the regulation, see Dissent at 1; (2) side-stepping the rulemaking process, thereby denying the public an opportunity to comment on the rule change, see id. at 14; and (3) prejudicing petitioners who, due to their uncertainty about whether section 51.53(c)(3) applies to SLRs, fail to invoke section 2.335 to seek a waiver of a GEIS finding codified in Part 51. See id. These concerns are unfounded.

First, our interpretation does not effect a de facto regulatory change; rather, it gives effect to Commission intent that has been rooted in the Part 51 regulatory purpose and structure from the outset. See supra Part III.A.2. Nothing in the APA forbids a regulatory interpretation that is permitted by the regulatory language, consistent with the regulatory purpose, supported by the regulatory structure, reinforced by published regulatory guidance, and reasonably relied upon by the industry.[50]

Nor is there merit to the dissent's concern that our interpretation improperly side-steps the rulemaking process and denies the public the opportunity to comment on a rule change. For the reasons already discussed, our interpretation does not effect a rule change and, accordingly, the public was not improperly denied an opportunity to comment. Rather, the public had an opportunity to comment between the rule's proposal in 1991 and its issuance in 1996. We note, moreover, that immediately before the agency issued the final rule in 1996, it gave the public an additional 30-day comment period, announcing that "[t]he NRC is soliciting public comment on this rule for a period of 30 days. . . . Absent a determination by the NRC that the rule should be modified, based on comments received, the final rule shall be effective on August 5, 1996. The comment period expires on July 5, 1996." 1996 Final Rule, 61 Fed. Reg. at 28,467.

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50 The dissent asserts that "the majority's application of the regulation creates . . . a significant uncertainty about what regulatory standards are applicable" to SLRS. Dissent at 1. However, nothing in the instant record suggests that the regulated industry has any uncertainty about the regulatory standards that apply to SLRs. When FPL prepared its ER, it did so in accordance with the prescribed process in section 51.53(c)(3) in reasonable reliance on (1) the Part 51 regulatory purpose and structure; (2) the guidance statements in Reg. Guide 4.2; and (3) the agency's expectation embodied in NUREG-1555. See supra note 43.

Nor does this record support the dissent's claim, Dissent at 1, that "the majority's application of the regulation creates . . . an obstacle to a petitioner's ability to know how to properly frame its contentions." See infra note 51 and accompanying text.

Although it is true that SACE and Joint Petitioners did not invoke section 2.335 to seek a waiver of a GEIS finding, their failure to do so was not based on any misapprehension regarding the applicability of section 51.53(c)(3) to FPL's SLR. To the contrary, these petitioners recognized that the applicability of section 51.53(c)(3) to SLRs was an open question, see, e.g., Joint Pet'rs Pet. at 16 n.71; SACE Reply at 3–9, and they made a conscious litigation choice not to take the precautionary step of invoking section 2.335. Petitioners were not unfairly prejudiced.[51]

Finally, the dissent opines that, unless its interpretation is accepted, the NRC might be encouraged to take improper "short cuts to amending its regulations in future adjudicatory proceedings." Dissent at 15. This concern lacks merit because it is grounded on the erroneous premise that section 51.53(c)(3) applies only to initial license renewal applicants. Moreover, although we decline to base our regulatory analysis on the notion that the NRC might engage in administrative misconduct in future adjudicatory proceedings, see Nat'l Small Shipment Traffics Conference, Inc. v. Interstate Commerce Comm'n, 725 F.2d 1442, 1450 (D.C. Cir. 1984), we nevertheless note that "the APA contains a variety of constraints" and remedies that serve to prevent agencies from taking improper short cuts when revising their regulations. Perez v. Mortg. Bankers Ass'n, __ U.S. __, __, 135 S. Ct. 1199, 1209 (2015).

[51] In the litigation context, it is axiomatic that when a regulation (or statute) lacks clarity, it is incumbent on a party or its representative to (1) identify the uncertainty; and (2) pursue a litigation strategy that protects the party's interests. Where, as here, a party refrains from advancing an argument, that argument is deemed to be waived. See e.g., Hormel v. Helvering, 312 U.S. 552, 556 (1941); District of Columbia v. Air Fla., Inc., 750 F.2d 1077, 1084–85 (D.C. Cir. 1984).

B. SACE ESTABLISHES STANDING, AND EACH OF ITS TWO PROFFERED CONTENTIONS IS ADMISSIBLE IN PART

1. SACE Establishes Standing

SACE satisfies the requirements for representational standing, which are discussed supra Part II.A.[52] SACE states that it is "a nonprofit, nonpartisan membership organization that promotes responsible energy choices that solve global warming problems and ensure clean, safe and healthy communities throughout the Southeast." SACE Pet. at 3. The environmental interests it seeks to protect in this proceeding are thus germane to its organizational purpose. Further, SACE provides declarations from three members who (1) live within 50 miles of the Turkey Point site and therefore have standing in their own right pursuant to the proximity presumption; and (2) authorize SACE to represent their interest in this proceeding, thus rendering it unnecessary for them to participate as individuals. See id., attach. 1, Decl. of Dan Kipnis ¶¶ 2, 4 (June 19, 2018); id., attach. 2, Decl. of Mark P. Oncavage ¶¶ 2, 4 (June 25, 2018); id., attach. 3, Decl. of Richard Reynolds ¶¶ 2, 4 (June 20, 2018).

2. Each of SACE's Two Proffered Contentions is Admissible in Part

SACE proffers two contentions alleging deficiencies in FPL's ER, and both are admissible in part. The Board admits Contention 1 to the extent it challenges the adequacy of the ER's discussion of the impacts of continued operation of the cooling canal system (CCS) on the American crocodile and its critical seagrass habitat. The Board admits Contention 2 to the extent it claims that the ER improperly fails to consider as a reasonable alternative to the proposed action a scenario under which the existing CCS is replaced with draft mechanical cooling towers. We reject as inadmissible the other portions of Contentions 1 and 2.

52 Neither FPL nor the NRC Staff challenges SACE's representational standing. See FPL Answer to SACE Pet. at 2; NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet. at 10–11.

a. Contention 1 Is Admissible in Part

In Contention 1, SACE asserts that the ER contains an inadequate discussion of the environmental impacts of the CCS and, accordingly, that there is no basis for its conclusion that the environmental effects of operating the CCS through the subsequent renewal term will be small. See SACE Pet. at 6, 8. In support of this assertion, SACE identifies three putative defects in the ER (which we designate as Contentions 1A, 1B, and 1C), each of which involves an alleged inadequate discussion of the environmental impacts of the CCS. See id. at 6–7. We examine each alleged defect in turn.

i. Contention 1A: Inadequate Analysis of Environmental Impacts of CCS on Crocodile Habitat, Biscayne Aquifer, and Biscayne Bay

SACE claims that the ER underestimates or ignores “the environmental impacts to the surrounding water resources by continuing to use the [CCS] for cooling of Turkey Point Units 3 and 4.” SACE Pet. at 6. This part of the contention challenges the ER’s alleged failure “to provide an adequate analysis of the environmental impacts of the CCS on the chemistry of groundwater, surface water and its aquatic life, and the CCS’[s] own ecosystem.” Id. SACE asserts that the ER incorrectly minimizes the significance of the CCS’s environmental impacts on (1) the American crocodile habitat and, as a result, on the crocodile population, id. at 19–20; (2) the Biscayne Aquifer related to the hypersaline plume, id. at 17–18; and (3) the Biscayne Bay related to nutrient releases. Id. at 18–19.

The NRC Staff does not oppose admission of Contention 1A insofar as it challenges the adequacy of the ER’s “analysis of the impacts of continued CCS operation on the critical habitat of the American crocodile.” NRC Staff Answer to Joint Pet’rs Pet. and SACE Pet. at 59. FPL disagrees, arguing that SACE provides no factual support to show that “the decline in American crocodile nest and hatchling numbers observed in 2015 and 2016 (as reported in the ER) indicate a long-term trend that will somehow be exacerbated by continued CCS operations and extend through the SLR period.” FPL Answer to SACE Pet. at 36. Further, FPL cites a newspaper article that reported substantial increases in the number of nests and hatchlings in the CCS for 2018. Id. at 35.[53] Finally, FPL argues that this aspect of the contention fails to raise a genuine dispute because it ignores the ER's discussion of FPL's crocodile management plan. Id. at 36.

We agree with the NRC Staff that this aspect of the contention is admissible. Although the ER discusses a crocodile management plan, we conclude that SACE raises a genuine factual dispute as to whether the ER adequately assesses the impacts of continued operation of the CCS on the American crocodile and its critical seagrass habitat. As the NRC Staff pointed out, see NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet. at 60, SACE does not dispute the adequacy of FPL's crocodile monitoring and protection plan, but rather challenges the ER's conclusion that "the American crocodile population continues to remain in a much stronger position than before the . . . CCS was established." SACE Pet. at 19 (citing ER at 3-195). The impacts of a license renewal on threatened species is a factual issue that is within the scope of this proceeding, and SACE has provided expert support for its claim that the CCS is degrading the seagrass habitat by exposing it to excessive levels of salt and nutrients. See SACE Pet. at 20 (citing attach. 8, Expert Report of James Fourqurean, Ph.D. at 1–3 (May 14, 2018)). Although the ER acknowledges that a decline in the crocodile population has occurred in recent years, SACE argues that it must also take a hard look at the fact that this decline signals a critical loss of seagrass bed habitat for a threatened species caused by operation of the CCS, see SACE Pet. at 19, and that it must address the "cumulative effects of the CCS on the American Crocodile." Id. at 27. We agree. We therefore admit Contention 1A as follows: The ER fails adequately to analyze the impacts (including cumulative) of continued CCS operation on the American Crocodile and its critical seagrass habitat.

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[53] FPL cites the following newspaper article: Theresa Java, Turkey Point's Canal Berms Ideal for Crocodile Clutches, Keysnews.com (Aug. 8, 2018), https://keysnews.com/article/story/turkey-points-canal-berms-ideal-for-crocodile-clutches/.

We conclude that all other aspects of Contention 1A are not admissible. First, to the extent Contention 1A claims that the ER underestimates the impacts related to tritium releases to groundwater, it is inadmissible because (1) it lacks the requisite support, see 10 C.F.R. § 2.309(f)(1)(v); and (2) it fails to raise a genuine dispute with the ER. See id. § 2.309(f)(1)(vi). Although SACE's experts provide support regarding tritium releases to Biscayne Bay, see SACE Reply at 12–13, they fail to do so regarding tritium releases to groundwater. Moreover, although SACE's petition states that the hypersaline plume includes radioactive tritium, and that tritium, among other pollutants, affects "the underlying Biscayne Aquifer and its protected G-II groundwater," SACE Pet. at 6, SACE provides no explanation for why releases of "tritium as one of numerous contaminants . . . pose[s] an unacceptable environmental risk" to groundwater. SACE Reply at 10. The ER acknowledges that "tritium is routinely released to the cooling canals and migrates into the groundwater," but states that the releases are "in concentrations that do not present an environment or health risk either onsite or offsite." ER at 3-114. SACE does not specifically dispute this, and its experts do not provide support for the claim that the environmental impacts of tritium releases on groundwater have been understated or that measured tritium concentrations are above permissible levels. This aspect of the contention is therefore inadmissible pursuant to section 2.309(f)(1)(v) and (vi).

With regard to the other aspects of Contention 1A relating to impacts to the Biscayne Bay and Aquifer, the NRC Staff and FPL argue that they constitute impermissible challenges to the regulations. Specifically, the NRC Staff states, and FPL agrees, that the following environmental impacts challenged by SACE constitute Category 1 issues that cannot be challenged in this litigation in the absence of a waiver, which SACE has not sought:

> [T]he environmental impacts . . . [regarding] (1) altered salinity gradients in surface waters, (2) groundwater quality degradation, (3) exposure of aquatic organisms to radionuclides, (4) the effects of non-radiological contaminants on aquatic organisms, (5) cooling system impacts on terrestrial resources, and (6) radiation (tritium) exposures to the public.

NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet. at 62, 63; see FPL Answer to SACE Pet. at 14–15. We agree that SACE's challenges in Contention 1A relating to the above impacts implicate Category 1 issues, and are thus outside the scope of this proceeding under 10 C.F.R. § 2.309(f)(1)(iii). Because SACE did not seek a waiver, these challenges must also be rejected pursuant to 10 C.F.R. § 2.335.[54]

ii. Contention 1B: Inadequate Analysis of Mitigation Measures to Reduce Salinity Resulting from Operation of CCS

In Contention 1B, SACE argues that the ER overstates the "effectiveness of existing and planned mitigative measures to reduce and remove the hypersaline plume," SACE Pet. at 21–22, and fails to account for the "[n]egative impacts of mitigation measures to reduce salt levels in the CCS." Id. at 23–24; see also id. at 7 (alleging that the ER fails to consider that FPL's mitigative efforts to "freshen" the CCS to reduce its salinity will negatively impact FPL's attempts to reduce the hypersaline plume).

The NRC Staff responds that SACE's argument essentially challenges the adequacy of the ER's discussions related to "altered salinity gradients in surface waters" and "groundwater quality degradation," both of which are Category 1 issues and, therefore, not subject to direct or indirect challenge absent a waiver pursuant to 10 C.F.R. § 2.335. See NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet. at 62–63. FPL makes a similar argument, stating that this

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[54] FPL further argues that SACE's claims regarding these impacts to the Biscayne Aquifer and Bay lack factual support. See FPL Answer to SACE Pet at 15. Specifically, FPL argues that the ER has "fully recognized and disclosed" the plume migration and its impacts to the Biscayne Aquifer, and that FPL is in compliance with the relevant Florida Department of Environmental Protection (FDEP) Consent Order and Miami-Dade County Department of Regulatory and Economic Resources (DERM) Consent Agreement, which were entered into specifically to address CCS-related groundwater impacts. Id. at 18–20. As to any alleged CCS impacts to the Biscayne Bay, FPL argues that "the impairment status of Biscayne Bay/Card Sound is unrelated to the operation of the CCS[, and] SACE and its experts provide no facts to support a contrary conclusion, or their claim that alleged 'nutrient seepage from the CCS' is having significant adverse impacts on Biscayne Bay water quality." Id. at 22 (quoting SACE Pet. at 19). We agree with FPL that this provides an alternative ground for inadmissibility pursuant to 10 C.F.R. § 2.309(f)(1)(v).

aspect of the contention is inadmissible pursuant to Commission precedent establishing that license renewal applicants "'need not address mitigation for issues' designated Category 1." See FPL Answer to SACE Pet. at 22–23 (quoting Entergy Nuclear Generation Co. (Pilgrim Nuclear Power Station), CLI-10-14, 71 NRC 449, 471 (2010)). FPL thus argues that "SACE's challenges to the adequacy of FPL's CCS-related mitigation measures (which involve Category 1 issues) are outside the scope of this proceeding as a matter of law." Id. at 23. We agree that Contention 1B is inadmissible for the alternative reasons that (1) it is an impermissible challenge to a Category 1 issue pursuant to section 2.335; and (2) it is outside the scope of this proceeding pursuant to section 2.309(f)(1)(iii).[55]

iii. Contention 1C: Inadequate Analysis of Cumulative Environmental Impacts

Finally, SACE argues that the ER "ignores or underestimates the cumulative impacts of past and future operations of the CCS." SACE Pet. at 7. In particular, SACE objects to the ER's failure to examine several issues within its cumulative impact analysis, including:

(1) FPL's efforts to contain pollutants from the CCS, including an examination of the "effectiveness and adverse effects of all of its mitigation measures, past, present, and proposed," id. at 25;

(2) The "combined effects of the L-31E levee and evaporation from the CCS on the degree to which the CCS and the underlying aquifer have become hypersaline and contaminated other parts of the aquifer and Biscayne Bay," id. at 26;

(3) The "cumulative impacts of the CCS, combined with other environmental factors, on hypersalinity in the CCS and the

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55 The NRC Staff and FPL also oppose admission of the challenge to mitigation measures because it depends on the following unsupported assumptions: FDEP's and/or DERM's mitigation measures are inadequate; FPL will not comply with FDEP's Consent Order and/or DERM's Consent Agreement; and FDEP and/or DERM will not enforce their own legal requirements. See NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet. at 64–65; FPL Answer to SACE Pet. at 23–26. FPL further argues that SACE's claims about mitigation measures are factually incorrect, unsupported, and require the NRC Staff to reexamine and/or overrule the judgments of state regulators. See FPL Answer to SACE Pet. at 26–29. We agree that the above arguments constitute alternative grounds for inadmissibility.

aquifer beneath," including the "interaction of environmental factors such as salinity, turbidity, and algal concentrations with the operation of the CCS," id.;

(4) The "degree to which FPL, by attempting to mitigate one environmental problem (hypersalinity in the CCS) has seriously aggravated another environmental problem: groundwater and surface water pollution," including the "net result of increasing the hydraulic head on the hypersaline plume by pumping more water into the CCS at the same time that FPL attempts to draw the plume back to the site boundary by pumping out the aquifer," id. at 27;

(5) The impacts due to "demand for water to cool or freshen the CCS . . . in relation to the demand for water to restore the Everglades, such as the water in the L-31E Canal." Id.

Additionally, SACE challenges the ER's conclusion that the cumulative impacts "will be small because FPL will comply with its permits for the CCS" because "the history of Turkey Point's operation shows that FPL is not in compliance with its permits." Id. at 24.

We conclude that Contention 1C is not admissible. First, regarding the cumulative impacts related to hypersalinity and mitigation measures, as with Contention 1B, each of the alleged omissions relates to environmental impacts that involve Category 1 issues (i.e., altered salinity gradient and groundwater degradation). This aspect of Contention 1C is inadmissible for the alternative reasons that it is (1) an impermissible challenge to a Category 1 issue pursuant to section 2.335; and (2) outside the scope of this proceeding pursuant to section 2.309(f)(1)(iii). See NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet. at 62; FPL Answer to SACE Pet. at 8–12.

Second, the aspect of Contention 1C that attacks the adequacy of the ER's analysis of cumulative impacts in light of FPL's history of noncompliance with its permits relating to the CCS is inadmissible for failing to raise a genuine dispute pursuant to section 2.309(f)(1)(vi). The ER's conclusion that cumulative impacts will be small is based on the mitigation measures imposed by FDEP in a Consent Order and by DERM in a Consent Agreement. See FPL Answer to SACE Pet. at 42. Notably, SACE does not assert that FPL currently is violating any requirement imposed by these regulatory agencies. Nor does SACE make any credible showing that (1) FDEP or DERM will fail to enforce State of Florida and local environmental requirements; or (2) FPL will commit a future violation that would alter the cumulative impacts analysis in the ER. Rather, SACE essentially argues that FPL's past violations of permit requirements, standing alone, are sufficient to raise a genuine dispute with the ER's conclusion that cumulative environmental impacts of the CCS will be small because FPL will comply with its current permit. We disagree. Pursuant to binding case law, we accord "substantial weight" to the determination of FDEP and DERM that FPL will comply with its legal obligations. See Pub. Serv. Co. of N.H. (Seabrook Station, Units 1 & 2), CLI-77-8, 5 NRC 503, 527 (1977) (holding that a finding of environmental acceptability made by a competent state authority [pursuant to a thorough hearing] "is properly entitled to substantial weight in the conduct of our own NEPA analysis.") (internal quotation marks omitted); cf. Pac. Gas & Elec. Co. (Diablo Canyon Power Plant, Units 1 & 2), CLI-03-2, 57 NRC 19, 29 (2003) (absent evidence to the contrary, Commission will assume that licensee will comply with license obligations). FPL's past violations in this case, standing alone, do not constitute sufficient information to give rise to a genuine dispute with the assumption that FDEP and DERM will enforce, and FPL will comply with, the legally mandated mitigation measures in the permits. See Fla. Power & Light Co. (Turkey Point Nuclear Generating Units 3 & 4), CLI-16-18, 84 NRC 167, 174–75 n.38 (2016).[56]

Finally, we conclude that SACE's argument concerning the potential water use conflict between freshening the CCS and other programs like the Central Everglades Restoration Program (CERP) lacks factual support and does not raise a genuine dispute with FPL's license renewal application. See NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet. at 61. SACE argues that because FPL has been allowed "to remove water from the L-31E Canal on an

[56] This is not to say that the NRC Staff, in compiling the draft SEIS, is absolved from conducting an independent review of the relevant permits pursuant to its assessment of cumulative impacts. See Tr. at 131–33, 215–16. SACE provides no basis for concluding that the NRC Staff would fail to conduct such a review.

emergency basis to reduce salinity levels in the CCS" there is the potential for "conflict with the use of canal water reserved for the CERP." SACE Pet. at 15. SACE therefore argues, on this basis alone, that the ER was required to analyze the cumulative impacts of the demand for water to freshen the CCS in relation to the demand for water to restore the Everglades. Id. at 27. This possible use of water on an emergency basis at some unspecified point in the future is too speculative a concern to raise a genuine dispute. Moreover, SACE does not provide the required facts or expert opinions to support admission of this aspect of Contention 1C. The only factual support it provides is that the L-31E canal was once used to supply water to the CCS, and it might be used again at some time in the future because the ER does not fully rule out the possibility of using that canal for freshening. See SACE Reply at 19. SACE cites to its expert report for the proposition that there may be conflicts over the need for water from the L-31E Canal for the CERP and the CCS's freshening program. SACE Pet. at 13–14 (citing attach. 4, Expert Report of William Nuttle at 10 [hereinafter Nuttle Report]). But that portion of the report does not discuss use of the L-31E Canal for freshening CCS water; instead, it discusses the potential for the hydraulic plume to reach and impact the quality of the L-31E Canal, which is a different issue. See Nuttle Report at 10. Therefore, Contention 1C is not admitted.[57]

b. Contention 2 Is Admissible in Part

In Contention 2, SACE argues that FPL's ER improperly "failed to consider the reasonable alternative of cooling the Turkey Point Units 3 and 4 reactors with mechanical draft cooling towers." SACE Pet. at 29. SACE asserts that FPL is required to consider reasonable mitigation alternatives pursuant to 10 C.F.R. §§ 51.45 and 51.53(c)(2), see id., and SACE provides the report of an expert who opined that mechanical cooling towers would (1) eliminate the adverse environmental impacts of the CCS; (2) allow the CCS to be restored to a thriving

[57] SACE also argues that the ER fails to discuss the "cumulative effects of the CCS on the American Crocodile." SACE Pet. at 27. This argument is included in the portion of Contention 1A that we found to be admissible. See supra Part III.B.2.a.i.

seagrass community and wildlife habitat; and (3) be a feasible and cost-effective alternative to the CCS. See id. at 30–31 (citing attach. 10, Expert Report of Bill Powers (May 14, 2018) [hereinafter Powers Report]).

The NRC Staff acknowledges that it has a regulatory obligation to consider reasonable "alternatives available for reducing or avoiding adverse environmental effects." NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet. at 68–69 (quoting 10 C.F.R. § 51.71(d)). The Staff does not dispute that SACE provides an adequate factual basis for its assertion that mechanical draft towers are a reasonable alternative to the CCS, nor does the Staff dispute SACE's statement that FPL's ER "omits consideration of a cooling tower alternative." Id. at 68. The Staff therefore does not oppose admitting Contention 2 "insofar as it asserts that the Applicant's [ER] omits consideration of mechanical draft cooling towers in connection with license renewal of Turkey Point Units 3 and 4, as a reasonable alternative to [the existing CCS]." Id.

We conclude that Contention 2 is an admissible contention of omission. Contrary to FPL's assertion, see FPL Answer to SACE Pet. at 51, Contention 2 is within the scope of the proceeding, and it raises a genuine dispute on a material fact to the extent it alleges that FPL's ER improperly fails to consider mechanical draft cooling towers as a reasonable alternative for reducing or avoiding adverse impacts on the threatened American Crocodile and its critical seagrass habitat. See SACE Pet. at 30; Powers Report at 1–5; supra Part III.B.2.a.i. Although neither the NRC Staff nor FPL is required to select the most environmentally superior alternative, NRC regulations require the ER and the EIS to consider "alternatives available for reducing or avoiding adverse environmental impacts." 10 C.F.R. §§ 51.45(c) and 51.71(d); see S. Nuclear Operating Co. (Early Site Permit for Vogtle ESP Site), LBP-07-3, 65 NRC 237, 259–

261, 280 (2007) (admitting a contention regarding dry cooling as a NEPA alternative in light of the sensitive biological resources affected).[58]

We therefore admit Contention 2 as follows: In light of the adverse impact of continued CCS operations on the threatened American crocodile and its critical seagrass habitat, the ER is deficient for failing to consider mechanical draft cooling towers as a reasonable alternative to the CCS in connection with the license renewal of Turkey Point Units 3 and 4.[59]

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[58] To be clear, Contention 2 focuses on the ER's failure to consider mechanical draft cooling towers as a reasonable and feasible alternative to the existing CCS for reducing or avoiding adverse environmental effects to sensitive biota. The NRC Staff states, and we agree, that the admissible scope of Contention 2 does not extend to requiring a discussion of the environmental impacts resulting from operation of the CCS, because Contention 2 does not point to any alleged deficiencies in the ER regarding its discussion of environmental impacts of CCS operation. See NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet. at 69.

[59] Prior to oral argument, we understood the Staff to acknowledge that Contention 2 satisfied the admissibility requirements in 10 C.F.R. § 2.309(f)(1) as a contention of omission. See NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet. at 68–69. At oral argument, however, the Staff seemed to take the position that, on the one hand, it did not oppose admission of Contention 2 as a contention of omission, see Tr. at 156, but that, on the other hand, neither NEPA nor NRC regulations requires FPL or the NRC Staff to consider mechanical cooling towers as a reasonable alternative to the CCS. See, e.g., id. at 156, 158, 159. In petitioners' view, the position taken by the NRC Staff at oral argument was "very different" from the position it took in its brief. See id. at 255. Petitioners therefore requested that the NRC Staff be required to provide its seemingly new views in writing so the other participants would have the opportunity to respond. See id. We granted petitioners' request, id. at 257; supra notes 19 and 20, and based on our review of the supplemental briefs, we conclude that the NRC Staff's "clarified position" has no material impact on its position (or our determination) that Contention 2 satisfies the admissibility criteria as a contention of omission.

After the supplemental briefs had been filed, petitioners moved for leave to respond to what they perceived as a newly raised argument in FPL's brief. See Petitioners' Motion for Leave to Respond to Applicant's Response to the NRC Staff's Clarification Regarding the Admissibility of Proposed Cooling Tower Contentions (Jan. 15, 2019); Petitioners' Response to Applicant's New Arguments on the Admissibility of Petitioners' Cooling Tower Contentions (Jan. 15, 2019). FPL and the NRC Staff opposed petitioners' motion. See Applicant's Answer to Petitioners' Joint Motion for Leave to Respond to Applicant's Response to the NRC Staff's Clarification (Jan. 22, 2019); NRC Staff's Answer to Petitioners' Motion for Leave to Respond to Applicant's Response to the NRC Staff's Clarification (Jan. 25, 2019). Given our ruling on the admissibility of Contention 2, we deny petitioners' motion as moot.

C. JOINT PETITIONERS ESTABLISH STANDING, AND PROFFER TWO CONTENTIONS THAT ARE ADMISSIBLE IN PART

1. Joint Petitioners Establish Standing

Joint Petitioners consist of the following three organizations: (1) Friends of the Earth, Inc. (FOE); (2) Natural Resources Defense Council, Inc. (NRDC); and (3) Miami Waterkeeper, Inc. (Waterkeeper). All three organizations have demonstrated that the interests they seek to protect in this proceeding are germane to their organizational purposes.[60] Further, all three organizations provide declarations from members who (1) live within 50 miles of the Turkey Point site and therefore have standing in their own right pursuant to the proximity presumption; and (2) authorize their respective organizations to represent their interests in this proceeding, thus rendering it unnecessary for them to participate as individuals. See, e.g., Joint. Pet., attach. B, Decl. of Anne Hemingway Feuer ¶¶ 1, 4, 14 (June 29, 2018) (member of FOE); id., attach. H, Decl. of Phillip Stoddard ¶¶ 1, 3, 13 (July 24, 2018) (member of NRDC); id., attach. J, Decl. of Daniel Parobok ¶¶ 4, 7 (July 30, 2018) (member of Waterkeeper). Joint Petitioners, therefore, satisfy the requirements for representational standing. See supra Part II.A.[61]

2. Joint Petitioners Proffer Two Contentions that are Admissible in Part

Joint Petitioners proffer five contentions (Contentions 1-E though 5-E) alleging deficiencies in FPL's ER. We conclude that Contentions 1-E and 5-E are admissible in part. Specifically, we admit Contention 1-E to the extent it claims that the ER improperly failed to

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[60] See Joint Pet'rs Pet. at 2 (FOE's mission includes "defend[ing] the environment" and "minimiz[ing] the risks that nuclear facilities pose to its members and to the general public."); id. at 5 (NRDC's mission includes "maintain[ing] and enhanc[ing] environmental quality" by working to "minimize the risks that nuclear facilities pose to its members and to the general public."); id. at 6–7 (Waterkeeper's mission includes "defend[ing], protect[ing], and preserv[ing] the aquatic integrity of South Florida's watershed and wildlife.").

[61] Neither FPL nor the NRC Staff challenges Joint Petitioner's representational standing. See FPL Answer to Joint Pet'rs Pet. at 2; NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet. at 9–10.

consider mechanical draft cooling towers as a reasonable alternative to the CCS.[62] We also admit Contention 5-E to the extent it challenges the ER's failure to recognize Turkey Point Units 3 and 4 as a source of ammonia in surrounding freshwater wetlands, as well as its failure to consider the impacts of ammonia discharges on threatened and endangered species and their critical habitat. We reject as inadmissible the other portions of Contentions 1-E and 5-E, and all of Contentions 2-E, 3-E, and 4-E.

a. Contention 1-E Is Admissible in Part

In Contention 1-E, Joint Petitioners assert that the ER "fails to consider a reasonable range of alternatives to the proposed action, as required by NEPA and NRC implementing regulations." Joint Pet'rs Pet. at 15–16. More particularly, they argue that the ER improperly omits consideration of the "reasonable and feasible" alternative of replacing the CCS with mechanical draft cooling towers to reduce the adverse environmental impacts of the CCS. Id. at 16, 19. Joint Petitioners provide factual information in support of their assertion that mechanical draft cooling towers would be a reasonable and feasible alternative, see id. at 19–22, and they claim that failing to discuss this alternative violates 10 C.F.R. § 51.45(c), which requires the ER to include a discussion of "'alternatives available for reducing or avoiding adverse environmental effects,'" including impacts on "American crocodiles, an endangered species," and the "American crocodile habitat." Id. at 18, 23, 24.

Consistent with its position concerning SACE's Contention 2, the NRC Staff does not oppose admitting this contention "insofar as it asserts that [FPL's ER] omits consideration of mechanical draft cooling towers in connection with license renewal of Turkey Point Units 3 and 4, as a reasonable alternative to use of the plants' [CCS]." NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet. at 29–30. FPL, on the other hand, argues that Contention 1-E is

62 This admissible portion of Contention 1-E is identical to the portion of SACE Contention 2 that we found to be admissible. See supra Part III.B.2.b.

inadmissible in its entirety for essentially the same reasons it argued against admitting SACE Contention 2. See FPL Answer to Joint Pet'rs Pet. at 8–9.

For the reasons we admitted SACE Contention 2, and subject to the same limitations, see supra Part III.B.2.b, we admit Contention 1-E as follows: In light of the adverse impact of continued CCS operations on the threatened American crocodile and its critical seagrass habitat, the ER is deficient for failing to consider mechanical draft cooling towers as a reasonable alternative to the CCS in connection with the license renewal of Turkey Point Units 3 and 4.[63]

b. Contention 2-E Is Not Admissible

In Contention 2-E, Joint Petitioners allege that "the [ER] fails to adequately consider the cumulative impacts of continued operation of Units 3 and 4." Joint Pet'rs Pet. at 30. Specifically, they argue that section 4.12 of the ER does not adequately address the cumulative impacts on water resources from the reasonably foreseeable effects of climate change on the

63 Contention 1-E also appears to challenge the ER's (1) discussion of the environmental impacts of continued CCS operation, see Joint Pet'rs Pet. at 19, 23–24, and (2) failure to consider other unspecified "alternatives to the proposed action." Id. at 15. Those aspects of the contention are not admissible because, contrary to 10 C.F.R § 2.309(f)(1)(v) and (vi), they fail to provide support sufficient to demonstrate a genuine dispute on a material issue of law or fact, or to include references to specific portions of the ER that they dispute. See NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet. at 30–31.

CCS, including sea level rise[64] and increasing air temperature.[65] Id. at 30–31. Joint Petitioners assert that the "reasonably foreseeable impacts from sea level rise will increase the risk of flooding at Turkey Point, including the potential for overtopping or breach[ing] of the canal system, leading to direct discharges of polluted canal water into surface water resources, including Biscayne Bay." Id. at 38. The "[h]igher air temperatures," they assert, "will increase the rate of evaporation in the [CCS] leading to more saline conditions. Higher salinity in the [CCS] will . . . adversely impact groundwater resources." Id.

We agree with the NRC Staff and FPL that this contention is not admissible. See NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet. at 34–41; FPL Answer to Joint Pet'rs Pet. at 27–36. First, even accepting Joint Petitioners' claims regarding future increases in sea level and air temperature, they fail to link those changes to the impacts of Turkey Point's continued operation. Joint Petitioners make conclusory assertions that (1) "sea level rise will increase the risk of flooding . . . , including the potential for overtopping or breach[ing] of the [CCS], leading to direct discharges of polluted canal water into surface water resources," Joint Pet'rs Pet. at 38; and (2) hotter air temperature will "increase the rate of evaporation in the [CCS] leading to more

[64] In support of their arguments regarding sea level rise, Joint Petitioners rely on the expert opinion of Dr. Robert Kopp, who states, inter alia, that "[t]hrough 2060, . . . there is between a 68 percent chance and a 95 percent chance that average sea-level rise at Key West [which Dr. Kopp posits as a comparable location to Turkey Point] will exceed 1 foot above the National Tidal Datum Epoch." Joint Pet'rs Pet., attach. N, Decl. of Dr. Robert Kopp at 12 (July 26, 2018). Dr. Kopp provides several probability estimates of future sea level rise, using a number of alternative assumptions. He states that, assuming storm characteristics do not change, the frequency and extent of extreme flooding associated with coast storms will increase because "a tide or storm of a given magnitude will produce a more extreme total water level than it would have with lower average sea level." Id. at 13. Consequently, "[i]f the sea level rises by one foot, . . . the probability of storms increasing water levels to the height of 2.0 feet becomes 50 [percent] rather than 1 [percent]." Joint Pet'rs Pet. at 35.

[65] With respect to increasing temperature, Joint Petitioners aver that in the Southeast United States for the 2036–2065 time period, air temperature increases are projected to range from 3.4 to 4.3 degrees Fahrenheit, Joint Pet'rs Pet. at 35, and changes in temperature extremes are projected to be 5.79 degrees Fahrenheit for the warmest day of the year and 11.09 degrees Fahrenheit for the "warmest 5-day, 1-in-10-year event" compared to the 1976–2005 period. Id. at 35–36.

saline conditions." Id. But they provide no support for their claims regarding putative environmental impacts. For example, they fail to discuss such necessary information as the relationship between their projected sea levels and the relevant elevations of the Turkey Point site, its sea level barriers, or the CCS, to support their claim that the site will be flooded and the CCS will be overtopped or breached. Similarly, although an increase in air temperature can lead to increased evaporation in the CCS, Joint Petitioners provide no support to demonstrate that the higher temperatures they postulate would increase evaporation in the CCS to any particular extent, much less to an extent that would be sufficient to increase the CCS salinity such that it would, in turn, affect the environment. Their failure to provide adequate support for these assertions renders the contention inadmissible pursuant to 10 C.F.R. § 2.309(f)(1)(v).

Additionally, to the extent Contention 2-E expresses concerns about overtopping and increased salinity of the CCS, it is also inadmissible pursuant to 10 C.F.R. § 2.309(f)(1)(vi) for failing to provide sufficient information to show a genuine dispute on a material issue of fact. Specifically, Joint Petitioners do not discuss how these impacts are reasonably foreseeable in light of the 2016 consent order between FPL and the FDEP that requires FPL to (1) "prevent releases of groundwater from the CCS to surface waters connected to Biscayne Bay that result in exceedances of surface water quality standards in Biscayne Bay"; and (2) perform a "thorough inspection of the CCS periphery" and "address any material breaches or structural defects." FDEP v. FPL, OGC File No. 16-0241 (Consent Order), at 7, 10–12 (June 20, 2016) [hereinafter Consent Order]. Even if overtopping were to occur, Joint Petitioners do not explain how it would impair the environment given that the consent order requires FPL to maintain an average annual CCS salinity at or below 34 practical salinity units (PSU) and to submit a detailed report outlining the potential sources of the nutrients found in the CCS and to implement a plan to minimize these nutrient levels. See id. at 7–10. Similarly, with respect to their argument that increased air temperature will result in higher CCS salinity, Joint Petitioners fail to explain why it is reasonably foreseeable that a temperature rise will lead to increased

CCS salinity in light of the consent order's requirement that FPL achieve an average annual CCS salinity at or below 34 PSU at the completion of the fourth year of freshening activities, and maintain that salinity thereafter. See id. at 7. Joint Petitioners' failure to address the above features of FPL's consent order renders Contention 2-E's concerns about overtopping and increased salinity inadmissible pursuant to section 2.309(f)(1)(vi).[66]

Finally, to the extent that Contention 2-E asserts that the ER fails adequately to address cumulative impacts on groundwater from the continued operation of the CCS during the renewal period, see Joint Pet'rs Pet. at 31, the contention ignores that FPL's ER discusses the cumulative impacts to groundwater resulting from the operation of Turkey Point Units 3 and 4 in combination with impacts to groundwater resulting from operation of "the other Turkey Point facilities and . . . from other projects and activities in the surrounding area," by incorporating by reference the cumulative impacts discussion in the 2016 EIS that was prepared for the combined licenses for Turkey Point Units 6 and 7. See ER at 4-68.[67] The ER concludes that the cumulative impacts to groundwater will be small and are managed because "FPL continues to comply with its permits for groundwater withdrawals and injection, the FDEP [consent order]

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[66] As discussed supra Part III.B.2.a.iii, any past incidents of FPL's failure to comply with the consent order do not, standing alone, constitute sufficient information to give rise to a genuine dispute in light of the case-law supported assumptions that FDEP will enforce, and FPL will comply with, the mandated obligations in the consent order.

[67] The 2016 EIS discusses the contribution from Turkey Point Units 3 and 4, as well as the effect of FPL's consent order with FDEP requiring freshening of the CCS, and the 2015 consent agreement with Miami-Dade County for remediating the hypersaline plume. See [EIS] for Combined Licenses (COLs) for Turkey Point Nuclear Plant Units 6 and 7, NUREG-2176, Vol. 2, at table 7-1 (Oct. 2016) [hereinafter Turkey Point Units 6 & 7 EIS].

It appears that FPL's ER does not cite to a specific page of the 2016 EIS. The Commission has admonished that it does not expect a litigant to merely reference large portions of material where doing so would force a tribunal to "sift through it in search of asserted factual support." NextEra Energy Seabrook, LLC (Seabrook Station, Unit 1), CLI-12-5, 75 NRC 301, 332 (2012). In our view, this admonition applies with equal force to an applicant's preparation of an ER. FPL's failure to provide a page-specific cite, however, does not change the Board's conclusion as to this contention's admissibility.

for freshening of the cooling canals, and the [consent agreement] with Miami-Dade County for remediation of the hypersaline plume." Id. at 4-69. Further, the ER cites NRC Reg. Guide 4.2, stating that for resource areas that are regulated through a permitting process "it may be assumed that cumulative impacts are managed as long as facility operations are in compliance with their respective permits." Id. Contention 2-E fails to provide sufficient information to raise a genuine dispute regarding these determinations in the ER, and for this reason it is not admissible pursuant to section 2.309(f)(1)(vi).

c. Contention 3-E Is Not Admissible

In Contention 3-E, Joint Petitioners claim that "[t]he [ER] (§§ 3 and 5) fails to comply with 10 C.F.R. § 51.53(c)(3)(iv) because it fails to analyze new and significant information regarding the effect of sea level rise on [the following] Category 1 and 2 issues," Joint Pet'rs Pet. at 39: (1) termination of plant operations and the decommissioning process (Category 1 issue), see id. at 45; (2) cumulative impacts on affected resources (Category 2 issue), see id. at 43–44; and (3) surface and groundwater use conflicts collectively labelled as "water resources" (Category 2 issues). See id. at 44.

The NRC Staff and FPL argue that this contention is not admissible. See NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet. at 43–46; FPL Answer to Joint Pet'rs Pet. at 36–45. We agree.

First, as Joint Petitioners concede, Joint Pet'rs Pet. at 40, the aspect of Contention 3-E that implicates "[t]ermination of plant operations and decommissioning" constitutes a challenge to a Category 1 issue. See 10 C.F.R. pt. 51, subpt. A, app. B, table B-1. This aspect of Contention 3-E is not admissible because it (1) is not subject to challenge in this adjudicatory proceeding where Joint Petitioners have failed to seek a rule waiver, see id. § 2.335; Entergy

Nuclear Vt. Yankee, LLC (Vt. Yankee Nuclear Power Station), CLI-07-3, 65 NRC 13, 18 n.15 (2007); and (2) is outside the scope of this proceeding. See 10 C.F.R. § 2.309(f)(1)(iii).[68]

Second, as to the portion of Contention 3-E that asserts the ER's "cumulative effects analysis . . . fails entirely to discuss the sea level rise-related impacts upon affected resources," Joint Pet'rs Pet. at 43–44, this aspect of the contention—which is reasonably characterized as a contention of omission—is not admissible, because it ignores that the ER incorporates by reference the Turkey Point 6 and 7 EIS, which does analyze the cumulative impacts of continued operation of nuclear reactors at the site in combination with climate change and sea level rise. See ER at 4-68; Turkey Point Units 6 & 7 EIS at I-5 to I-6. This aspect of Contention 3-E fails to raise a genuine dispute as required by 10 C.F.R. § 2.309(f)(1)(vi).

Finally, the portion of Contention 3-E alleging that the ER improperly ignores water resource conflicts insofar as it fails to "account for the effect sea level rise will have on freshwater availability, ground water resources, and release of polluted cooling water into Biscayne Bay," Joint Pet'rs Pet. at 44, fails to raise a genuine dispute. Although Joint Petitioners allege "frequent interchange of water from Biscayne Bay and the [CCS]," id. at 45, they provide no explanation for why this would cause conflicts in water use for either surface or groundwater resources. Instead, Joint Petitioners simply assert that sea level rise will eliminate the "closed-loop" nature of the CCS, but they do not explain why this would create or

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[68] FPL argues that this aspect of Contention 3-E is also inadmissible pursuant to section 2.309(f)(1)(v) because Joint Petitioners offer no support for their claim that sea level rise will affect FPL's ability to terminate plant operations and decommission the plant. See FPL Answer to Joint Pet'rs Pet. at 40. The NRC Staff argues that this aspect of Contention 3-E constitutes a challenge to an operating licensing issue that is beyond the scope of this SLR proceeding and, hence, is inadmissible pursuant to section 2.309(f)(1)(iii). NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet. at 46. We agree with both arguments.

exacerbate water use conflicts for either resource, thus rendering this aspect of Contention 3-E inadmissible pursuant to section 2.309(f)(1)(vi).[69]

d. Contention 4-E Is Not Admissible

In Contention 4-E, Joint Petitioners argue that the "[ER] (§ 3) erroneously fails to describe the reasonably foreseeable affected environment during the subsequent license renewal period (2032–2053) in violation of 10 C.F.R. § 51.53(c)(2)," which "renders Applicant's analyses of environmental impacts (§ 4), mitigating actions (§ 6), and alternatives analysis (§ 8) legally insufficient." Joint Pet'rs Pet. at 47. In particular, Joint Petitioners assert that the ER "fails to discuss the changes [caused by climate change] in the surrounding environment and their effects on Turkey Point, including sea level rise, increased air temperature, increased surface water temperature, acidification, annual precipitation, drought, and increased storm intensity." Id. at 48.

The NRC Staff and FPL argue that Contention 4-E is not admissible. See NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet. at 46–51; FPL Answer to Joint Pet'rs Pet. at 46–54. We agree.

Joint Petitioners are simply incorrect in asserting that the ER fails to address the effects of climate change during the license renewal period. The 2013 GEIS contains the potential effects of climate change that Joint Petitioners claim are missing from the ER, including sea level rise, increased air temperature, increased water temperature, increased water acidity,

[69] Joint Petitioners also do not explain how sea level rise will eliminate the "closed loop" nature of the CCS in light of FPL's consent order with FDEP, which requires that FPL conduct a "thorough inspection of the CCS periphery" and "address any material breaches or structural defects." Consent Order at 7, 10–12. Nor do they explain how any overtopping of the CCS would result in any significant environmental impacts in light of the consent order's requirements that FPL (1) maintain an average annual CCS salinity at or below 34 PSU; (2) submit a detailed report outlining the potential sources of nutrients in the CCS, and implement a plan to minimize these nutrient levels; and (3) prevent releases of groundwater from the CCS to surface waters connected to Biscayne Bay that result in exceeding of surface water quality standards in Biscayne Bay. See id. at 7–12; see also NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet. at 45; FPL Answer to Joint Pet'rs Pet. at 44.

increased precipitation, drought, and more intense hurricanes. See 2013 GEIS at 4-237 to 4-241.[70] The ER, in turn, describes the effects of climate change when combined with the effects of the proposed action. See ER at 4-69, 4-71. Additionally, the ER cites the Staff's EIS for the Turkey Point Units 6 and 7 combined licenses, which also discusses the effects of climate change at the site. See ER at 4-68. Contention 4-E is thus based on an erroneous factual premise, which renders it inadmissible pursuant to 10 C.F.R. § 2.309(f)(1)(v) and (vi).[71]

e. Contention 5-E Is Admissible in Part

In Contention 5-E, Joint Petitioners allege the ER "fails to address the adverse effect of operating the [CCS] for an additional 20 years on surface waters, freshwater wetlands, and endangered species present in those wetlands" in violation of 10 C.F.R. § 51.53(c)(3)(ii)(E). Joint Pet'rs Pet. at 58–59. Specifically, Joint Petitioners fault the ER for giving "no consideration to how the salinization of freshwater wetlands caused by the [CCS] will impact threatened or endangered species, and otherwise harm important plant and animal habitats," id. at 59, and for failing "to consider the impacts of ammonia discharges on threatened and endangered species and important habitat." Id. at 63. Regarding the latter assertion, Joint Petitioners provide factual support for concluding that (1) violations of surface water ammonia standards have been

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70 Section 4.12.3.2 of the 2013 license renewal GEIS describes the environmental impacts that could occur from changes in global and regional climate conditions, including generic descriptions of potential long-term impacts with examples of resource changes that could occur due to climate change. See GEIS at 4-237 to 4-241. Section 4.13 of the GEIS describes the cumulative impacts of the proposed action, focusing on resources that could be affected by the incremental impacts from continued operations associated with license renewal. See id. at 4-243 to 4-249.

71 Moreover, to the extent Joint Petitioners assert in Contention 4-E that section 51.53(c)(2) requires the ER to describe the "reasonably foreseeable affected environment during the subsequent license renewal period," Joint Pet'rs Pet. at 47, they are incorrect as a matter of law. The regulation requires that ERs "describe in detail the affected environment around the plant," not the "reasonably foreseeable" environment. 10 C.F.R. § 51.53(c)(2). This legal error also renders Contention 4-E inadmissible pursuant to section 2.309(f)(1)(iv) for failing to show that the issue raised is material to the findings the NRC must make to support the action in this proceeding.

observed in canals near Turkey Point; and (2) Turkey Point is a key source of that ammonia. See id. at 62 (citing attach. P, Letter from Wilbur Mayorga, Chief of Environmental Monitoring and Restoration Division, DERM, to Matthew J. Raffenberg, Senior Director of Environmental Licensing and Permitting, FPL (July 10, 2018)).

FPL opposes admission of Contention 5-E in its entirety as outside the scope, immaterial, unsupported, and failing to demonstrate a genuine dispute with the ER. See FPL Answer to Joint Pet'rs Pet. at 54–60.

The NRC Staff does not oppose admitting the portion of Contention 5-E that relates to "the impact of ammonia releases from Turkey Point Units 3 and 4 on endangered and threatened species." NRC Staff Answer to Joint Pet'rs Pet. and SACE Pet. at 54. The NRC Staff "recognizes that the impacts of continued operation of the CCS on threatened and endangered species and critical habitat is a Category 2 issue" that must be analyzed in the supplemental EIS on a site-specific basis, id. & n.225, and in the Staff's view, Joint Petitioners submitted sufficient supporting information to raise a genuine dispute with the ER regarding their assertions that "Turkey Point is a source of ammonia in freshwater wetlands surrounding the site, and that the potential impacts of such ammonia releases during the period of continued operation on threatened and endangered species should be analyzed." Id. at 54. The Staff opposes admitting all other portions of Contention 5-E. See id.

For the reasons stated by the NRC Staff, we conclude that Contention 5-E satisfies the admissibility requirements in 10 C.F.R. § 2.309(f)(1) to the extent it relates to the impact of ammonia releases from Turkey Point Units 3 and 4 on endangered and threatened species and their critical habitat. We therefore admit Contention 5-E as follows: The ER is deficient in its failure to recognize Turkey Point as a source of ammonia in freshwater wetlands surrounding the site, and in its failure to analyze the potential impacts of ammonia releases during the renewal period on threatened and endangered species and their critical habitat.[72]

The remaining portions of Contention 5-E are not admissible. First, to the extent that Contention 5-E asserts that the ER improperly fails to consider the impact of salinization on surface waters and freshwater wetlands caused by the CCS, see Joint Pet'rs Pet. at 59, it raises an impermissible challenge to a Category 1 issue. See 10 C.F.R. pt. 51, app. B, Table B-1 (identifying as Category 1 issues the impacts of license renewal to altered salinity gradients in surface waters, groundwater quality degradation at plants with cooling ponds in salt marshes (including Turkey Point, see 2013 GEIS at 4-50), and cooling system impacts on terrestrial resources in wetlands). This aspect of Contention 5-E is (1) not litigable in this adjudicatory proceeding where Joint Petitioners have failed to seek a waiver, see 10 C.F.R. § 2.335; and (2) outside the scope of this proceeding. See id. § 2.309(f)(1)(iii).[73]

Likewise inadmissible is the portion of Contention 5-E concerning the impacts of salinization on threatened and endangered species in the wetlands. That aspect of Contention 5-E assumes that (1) FDEP's 2016 Consent Order does not establish adequate mitigation measures to address the salinity issues caused by the CCS; (2) FPL will fail to comply with the

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[72] Joint Petitioners also assert that the CCS causes unspecified "other pollutants" to migrate into nearby surface waters and adversely impact the habitats of threatened and endangered species. See Joint Pet'rs Pet. at 59. Their failure to identify these putative "other pollutants" or to provide specific facts or expert opinion to support their claim renders this aspect of Contention 5-E inadmissible pursuant to 10 C.F.R. § 2.309(f)(1)(v).

[73] Joint Petitioners may not circumvent the regulatory bar against challenging a Category 1 issue by alleging the existence of new and significant information. See Joint Pet'rs Pet. at 60–62 (alleging significant migration of salt intrusion). As the Commission has held, "the new and significant information requirement in 10 C.F.R. § 51.53(c)(3)(iv) [does] not override, for the purposes of litigating the issues in an adjudicatory proceeding, the exclusion of Category 1 issues in 10 C.F.R. § 51.53(c)(3)(i) from site-specific review. . . . [A] waiver [is] required to litigate any new and significant information relating to a Category 1 issue." Limerick, CLI-12-19, 76 NRC at 384.

Consent Order; and/or (3) FDEP will fail to enforce the Consent Order and its regulations.[74] As we previously explained, absent evidence to the contrary (which Joint Petitioners fail to provide), we presume that FDEP will enforce, and FPL will comply with, the legally mandated measures in the Consent Order. See supra Part III.B.2.a.iii; see also supra note 55. We thus conclude that this aspect of Contention 5-E is inadmissible pursuant to 10 C.F.R. § 2.309(f)(1)(v) and (vi) for failing to provide sufficient information to give rise to a genuine dispute.

D. MR. GOMEZ FAILS TO PROFFER AN ADMISSIBLE CONTENTION

FPL argues that Mr. Gomez's petition should be rejected as a threshold matter because (1) it is untimely; (2) it does not comply with the NRC's mandatory E-Filing requirements; and (3) it fails to demonstrate standing. See FPL Answer to Gomez Pet. at 4–13. The NRC Staff disagrees with FPL regarding Mr. Gomez's standing, stating that he "has shown that he has standing to intervene, based on the proximity presumption." NRC Staff Answer to Gomez Pet. at 9. However, the Staff agrees that Mr. Gomez's petition should be denied because it was late and improperly filed and served. See id. at 26–29.

We need not address any of these threshold issues, because we agree with the NRC Staff and FPL that none of the contentions proffered by Mr. Gomez is admissible. See NRC Staff Answer to Gomez Pet. at 26–43; FPL Answer to Gomez Pet. at 13–24.[75]

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[74] The 2016 Consent Order requires FPL to submit and implement a plan that will "halt the westward migration of the hypersaline plume within 3 years of commencement of the remediation project and retract the hypersaline plume to the L-31E canal within 10 years." Consent Order at 9. FPL must report on the effectiveness of this plan at the conclusion of the fifth year of the plan's implementation. If the plan is ineffective, FPL must provide an alternative plan for FDEP approval, and then implement the FDEP-sanctioned plan. See id. at 10.

[75] The ten contentions proffered by Mr. Gomez are located in ten numbered paragraphs and subparagraphs in the section of his Petition entitled "Petitioner[']s Contentions." See Gomez Pet. at unnumbered pp. 1–7.

1. Contentions 1 and 2 Are Not Admissible

The first two putative contentions in Mr. Gomez's Petition constitute requests for extensions of time. First, Mr. Gomez opines that FPL's application was not available to the public for a sufficient time to allow adequate review, and he therefore requests an extension of sixty days beyond August 1, 2018, to allow "petitions for hearing, submissions of contention and limited appearance statements." Gomez Pet. at unnumbered p. 2. Second, Mr. Gomez asserts that there "are current municipal board & committee motions in process within [the] City of Miami in support of an extension to the public comment period and to enable a formal response by the City of Miami Commission." Id. Mr. Gomez therefore requests that "an [unspecified] extension [of time for] public comments be allowed in order to reasonably accommodate the City of Miami Commission with an opportunity to review the active motion[s] . . . and comment if [it] rules in favor of entering said comment." Id.

Mr. Gomez's requests for extensions of time do not constitute contentions challenging FPL's license renewal application, and they fail on their face to satisfy the contention admissibility requirements in 10 C.F.R. § 2.309(f)(1). See NRC Staff Answer to Gomez Pet. at 31–32.[76]

2. Contention 3 Is Not Before This Board

In Contention 3, Mr. Gomez requests "an [unspecified] extension [of time] in order to have sufficient opportunity to submit formal environmental scoping comments on issues arising under [NEPA]." Gomez Pet. at unnumbered p. 2. This portion of Mr. Gomez's Petition is not before us, because in its referral memorandum of Mr. Gomez's Petition to the Atomic Safety and Licensing Board Panel, the Office of the Secretary excluded this particular request and,

[76] Mr. Gomez's requests would not have fared any better if he had characterized them as extension requests. As the NRC Staff correctly states, his first request is untimely and is not supported by good cause, see NRC Staff Answer to Gomez Pet. at 31, and his second request is outside the scope of this adjudicatory proceeding. See id. at 32.

instead, referred it to the Office of the Executive Director for Operations for appropriate action. See Letter from Annette L. Vietti-Cook, Secretary, U.S. Nuclear Regulatory Commission, to E. Roy Hawkens, Chief Administrative Judge, Atomic Safety and Licensing Board Panel (Aug. 9, 2018).

3. Contention 4 Is Not Admissible

In Contention 4, Mr. Gomez contends that the "unlined cooling canals are leaking a host of caustic poisonous chemicals and highly saline waste water into our water supply." Gomez Pet. at unnumbered p. 3. He refers to a "clean up regime" that "FPL has currently entered into . . . with Miami-Dade County via the Department of Environmental Resource Management," id., and he requests that the "License Renewal Applications be withheld and withdrawn until the current clean up . . . is completed" and "until any law suits related to potential clean water act violations stated within ongoing FPL law suits . . . [are] settled." Id. at unnumbered pp. 3–4.

This environmental contention fails to provide a specific statement of law or reference a specific portion of the application that is disputed, as required by 10 C.F.R. § 2.309(f)(1)(i) and (vi). Additionally, to the extent Contention 4 asserts that FPL's renewal application is deficient pursuant to NEPA until an environmental clean-up is completed and any law suits related to potential Clean Water Act violations within ongoing FPL law suits are settled, see Gomez Pet. at unnumbered pp. 3–4, it is outside the scope of this proceeding pursuant to section 2.309(f)(1)(iii), because, as explained supra Part III.A.1, NEPA "seeks to guarantee process, not specific outcomes." Massachusetts v. NRC, 708 F.3d 63, 67 (1st Cir. 2013). Contention 4 also fails to satisfy section 2.309(f)(1)(v), because none of its assertions is supported by specific facts or expert opinions. And because Contention 4 lacks proper support, it fails to raise a genuine dispute on a material issue of law or fact, as required by section 2.309(f)(1)(vi).

4. Contention 5 Is Not Admissible

Contention 5 is a contention of omission in which Mr. Gomez asserts that FPL's ER fails to comply with 10 C.F.R. § 52.99(c) because the "Alternative Energy Sources review [does] not include solar nor wind power in [its] analysis." Gomez Pet. at unnumbered p. 4.

The legal basis for Contention 5 is flawed, because the regulatory requirement on which Mr. Gomez relies, section 52.99(c), governs combined license (COL) applications, not license renewals, thus rendering the contention inadmissible pursuant to section 2.309(f)(1)(ii) and (iii) as lacking a basis and outside the scope of this proceeding. Moreover, Contention 5 is based on an erroneous factual predicate. Contrary to Mr. Gomez's assertion, FPL's ER does include an analysis of solar and wind power alternatives. See ER at 7-4, 7-6 to 7-7, 7-9 to 7-10. Contention 5 is thus also inadmissible for failing to raise a genuine dispute with the ER as required by section 2.309(f)(1)(vi).

5. Contention 6 Is Not Admissible

Contention 6 is a contention of omission in which, again relying on section 52.99(c), Mr. Gomez asserts that the ER is incomplete because it fails to include a discussion of whether FPL intends to seek any power uprates for Units 3 and 4 during the renewal period. See Gomez Pet. at unnumbered pp. 4–5. Such a discussion is required, he claims, because if FPL were to seek a power uprate, and if one were granted, it could cause the plant's "safe maximum operating temperature" to be exceeded and entail "the risk of further expanding the poisonous and high salinity plume" in the groundwater. Id.

The legal basis for Contention 6 is flawed, because the regulatory requirement on which Mr. Gomez relies, section 52.99(c), governs COL applications, not license renewals, thus rendering the contention inadmissible pursuant to section 2.309(f)(1)(ii) and (iii) as lacking a basis and outside the scope of this proceeding. Contention 6 is also outside the scope of this proceeding because power uprates are a matter related to current plant operations and governed by 10 C.F.R. Part 50, not the license renewal requirements in Part 51 (environmental) or Part 54 (safety). Moreover, Mr. Gomez's concern that FPL might request an uprate sometime during the renewal period that might, in turn, implicate safety and environmental matters is based on unsupported conjecture and is therefore inadmissible pursuant to 2.309(f)(1)(v). Finally, Contention 6 fails to challenge a specific portion of FPL's application, much less raise a genuine dispute of material fact or law, as required by section 2.309(f)(1)(vi).

6. Contention 7 Is Not Admissible

In Contention 7, Mr. Gomez includes a block quote that appears to combine portions of "the current EIS, GEIS and SEIS and related supplements and [appendices]" to support his assertions that the ER is deficient because it is "based on the egregious misrepresentation and [sheer] lack of local governing sea level rise projections" and "how that impacts its high level waste and spent fuel onsite storage." Gomez Pet. at unnumbered p. 5.

To the extent that Contention 7 alleges that rising sea levels pose a potential risk to safe plant operations, including spent fuel storage, it raises a current licensing basis safety issue under 10 C.F.R. Part 50 that is outside the scope of this proceeding, contrary to section 2.309(f)(1)(iii). To the extent Contention 7 alleges an environmental issue concerning onsite storage of spent nuclear fuel, it raises a non-litigable and inadmissible Category 1 issue. See 10 C.F.R. pt. 51, subpt. A, app. B. Additionally, Contention 7 fails to satisfy section 2.309(f)(1)(v), because the block quote on which Mr. Gomez relies does not support his claim that there is an "egregious misrepresentation" or "lack of local governing sea level rise projections" in FPL's license renewal application.[77] Finally, Contention 7 fails to specify any

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[77] The NRC Staff accurately states that Mr. Gomez's block quote is "unattributed, and its reliability or meaning cannot be discerned." NRC Staff Answer to Gomez Pet. at 39. The NRC Staff also observes that Mr. Gomez's Petition includes a "[s]upplemental page" that quotes an excerpt from the Commission's decision on FPL's application for COLs for Turkey Point Units 6 and 7, Fla. Power & Light Co., (Turkey Point Nuclear Generating Units 6 & 7), CLI-18-1, 87 NRC 39, 59 (2018), regarding sea level rise at the site. See NRC Staff Answer to Gomez Pet. at 39–40. We agree with the NRC Staff that Mr. Gomez's mere quotation from CLI-18-1 does nothing to advance the admissibility of Contention 7. See id.

portion of FPL's application that is inadequate, and thus fails to establish a genuine material dispute with the application, as required to section 2.309(f)(1)(vi).

7. Contention 8 Is Not Admissible

Contention 8 alleges the NRC improperly concluded in the "current EIS, GEIS and SEIS and related supplements and appendi[ces]" that the "[e]nvironmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource." Gomez Pet. at unnumbered p. 5. Mr. Gomez asserts that this conclusion "contradict[s] . . . current environmental facts" because "a federal law suit is in play related to potential EPA violations, [and] an increasing plume migrates and expands both easterly and westerly from the current position threatening both our water supply and our federally protected bay." Id.

Although Mr. Gomez does not give a specific citation for the quote on which he bases Contention 8, the NRC Staff identified this quote as "the NRC's general definition of a 'SMALL' impact, as presented in its environmental impact statements prepared pursuant to NEPA, without reference to any particular environmental issue." NRC Answer to Gomez Pet. at 41. Contention 8 thus neither references a specific relevant portion of the license renewal application, nor demonstrates that a genuine dispute exists with the applicant, as required by section 2.309(f)(1)(vi). Moreover, Mr. Gomez fails to provide support for his position, as required by section 2.309(f)(1)(v), because he fails to identify the federal lawsuit he relies on, and he fails to explain his assertion that the law suit represents the "current environmental facts." Gomez Pet. at unnumbered p. 5.

8. Contention 9 Is Not Admissible

In Contention 9, Mr. Gomez states that FPL "is currently in negotiation[s] with Miami-Dade [County] related to [reclaimed wastewater] required to recharge the current cooling canals to a low enough temperature to maintain the cooling function." Gomez Pet. at unnumbered p. 6. Mr. Gomez describes "fears that the waste water discharge may negatively impact [FPL's ability through compliance with its consent order] to reduce [the introduction of] phosphorous and other caustic compounds into the bay and our water supply." Id. He requests that the application be "withheld and withdrawn until the water demand issue is resolved . . . for safe operation of the plant without further threatening our bay or drinking and agricultural water supply." Id.

Again, Mr. Gomez fails to provide alleged facts or expert opinions to support his assertion that the use of wastewater to recharge the cooling canals may present a threat to drinking water, groundwater, and safe operation of the plant, as required by section 2.309(f)(1)(v).[78] Nor does he refer to the specific sources and documents on which he intends to rely, as required by section 2.309(f)(1)(v). He also fails to reference a specific portion of the license renewal application that he disputes, as required by section 2.309(f)(1)(vi).

9. Contention 10 Is Not Admissible

In Contention 10, Mr. Gomez asserts that the license renewal application is deficient pursuant to 10 C.F.R. § 52.103(b) for the following reasons: (1) FPL allegedly projects a sea level rise of one foot by 2100,[79] which he asserts is inconsistent with projections of sea level rise by the United Nations, the U.S. Army Corps of Engineers, and the National Oceanic and Atmospheric Administration of, respectively, 31", 61", and 81"; and (2) FPL improperly fails to follow the POANHI – Process for Ongoing Assessment of Natural Hazard Information – SECY-15-0137 portion of the Post-Fukushima Near-Term Task Force Recommendations 2.2. See Gomez Pet. at unnumbered p. 6.

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[78] Contention 9 does not even provide adequate support for the proposition that Turkey Point Units 3 and 4 will use reclaimed wastewater as an additional source of cooling and CCS freshening during the renewal period. See FPL Answer to Gomez Pet. at 23 ("[T]here is no firm expectation or assumption in the [license renewal application] that Turkey Point Units 3 and 4 will use reclaimed wastewater during the SLR period.").

[79] Mr. Gomez initially states that FPL's sea level rise projection is "1"" (i.e., one inch), but in a later sentence he states the projection is one foot. See Gomez Pet. at unnumbered p. 6. We agree with the NRC Staff's assumption that Mr. Gomez means one foot. See NRC Staff Answer to Gomez Pet. at 42.

The legal basis for Contention 10 is flawed, because the regulatory requirement on which Mr. Gomez relies, section 52.103(b), governs COL applications, not license renewals, thus rendering the contention inadmissible pursuant to section 2.309(f)(1)(ii) and (iii) as lacking a basis and outside the scope of this proceeding. Additionally, although Mr. Gomez asserts that the license renewal application projects a one-foot sea level rise by 2100, he fails to specify where this projection appears in the application, if at all, and he thus fails to raise a genuine dispute with the application, as required by section 2.309(f)(1)(vi). The POANHI process that Mr. Gomez asserts should be used by FPL pertains to operational safety issues under 10 C.F.R. Part 50 with respect to flooding hazards, rather than to the aging management safety issues involved in the license renewal process; accordingly, this aspect of Contention 10 is not within the scope of this proceeding, as required by section 2.309(f)(1)(iii). Finally, to the extent that Contention 10 endeavors to raise an environmental challenge, it fails to provide any support or explanation as to how sea level rise, in combination with the effects of the continued operation of Turkey Point, will impact the environment, as required by section 2.309(f)(1)(v).

E. MONROE COUNTY, FLORIDA MAY PARTICIPATE AS AN INTERESTED GOVERNMENTAL PARTICIPANT

As relevant here, a licensing board "will afford an interested . . . local governmental body (county, municipality or other subdivision) . . . that has not been admitted as a party under § 2.309, a reasonable opportunity to participate in a hearing." 10 C.F.R. § 2.315(c). Section 2.315(c) does not require a demonstration of standing from an entity that seeks to participate as an interested governmental participant. Rather, it requires the entity to (1) identify those contentions on which it intends to participate; and (2) designate a single representative for the hearing. See id. The designated representative may

> introduce evidence, interrogate witnesses where cross examination by the parties is permitted, advise the Commission without [being required] to take a position with respect to the issue, file proposed findings in those proceedings where findings are permitted, and petition for review by the Commission under section 2.341 with respect to the admitted contentions.

Id.

As indicated supra Part I, Monroe County, Florida filed a request to participate as an interested governmental participant. The request explains that Monroe County borders Miami-Dade County and comprises natural resources including the Florida Keys, three national parks, four national wildlife refuges, and three state aquatic preserves. See Monroe County Request at unnumbered p. 1. Given its proximity to the Turkey Point facility,[80] Monroe County is concerned about the adverse impact of the CCS on (1) the County's drinking water; and (2) Biscayne Bay, which will threaten the tourism and fishing industries on which the County's identity and economy are based. See id. at unnumbered p. 2. Monroe County identifies SACE's two contentions as those in which it intends to participate, see id. at unnumbered p. 3, and it designates the Monroe County Board of County Commissioners as its representative. See id. at unnumbered p. 2.

We conclude that Monroe County satisfies the regulatory criteria for participating in this proceeding as an interested governmental participant, and we grant its request to participate on SACE's two contentions, as admitted.

[80] The NRC Staff advises that the Turkey Point facility and the CCS appear to be located about eight miles and four miles, respectively, from the nearest boundary of Monroe County. See NRC Staff Response to Monroe County at 5 n.23.

IV. CONCLUSION AND ORDER

For the foregoing reasons, we (1) grant SACE's hearing request, admitting Contention 1A and Contention 2 as framed by this Board;[81] (2) grant Joint Petitioners' hearing request, admitting Contention 1-E and Contention 5-E as framed by this Board;[82] (3) deny Mr. Gomez's hearing request; and (4) grant Monroe County's request to participate as an interested governmental participant.

Pursuant to 10 C.F.R. § 2.323(f)(1), we refer to the Commission our ruling infra Part III.A that section 51.53(c)(3) applies to the preparation of ERs in SLR proceedings. See supra note 46.

We deny as moot petitioners' motion dated January 15, 2019, which requested permission to respond to an FPL filing. See supra note 59.

This proceeding shall be conducted pursuant to the Simplified Hearing Procedures for NRC Adjudications described in Subpart L of 10 C.F.R. Part 2.

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[81] SACE Contention 1A (as admitted) states: The ER fails adequately to analyze the impacts (including cumulative) of continued CCS operation on the American Crocodile and its critical seagrass habitat. See supra p. 33.

SACE Contention 2 (as admitted) is identical to Joint Petitioners' Contention 1-E (as admitted) and states: In light of the adverse impact of continued CCS operations on the threatened American crocodile and its critical seagrass habitat, the ER is deficient for failing to consider mechanical draft cooling towers as a reasonable alternative to the CCS in connection with the license renewal of Turkey Point Units 3 and 4. See supra p. 41.

[82] Joint Petitioners' Contention 1-E (as admitted) is identical to SACE Contention 2 (as admitted) and states: In light of the adverse impact of continued CCS operations on the threatened American crocodile and its critical seagrass habitat, the ER is deficient for failing to consider mechanical draft cooling towers as a reasonable alternative to the CCS in connection with the license renewal of Turkey Point Units 3 and 4. See supra p. 44.

Joint Petitioners' Contention 5-E (as admitted) states: The ER is deficient in its failure to recognize Turkey Point as a source of ammonia in freshwater wetlands surrounding the site, and in its failure to analyze the potential impacts of ammonia releases during the renewal period on threatened and endangered species and their critical habitat. See supra pp. 52–53.

This Memorandum and Order is subject to appeal in accordance with the provisions in 10 C.F.R. § 2.311(b) and (d)(1).

It is so ORDERED.

THE ATOMIC SAFETY
AND LICENSING BOARD

/RA/

E. Roy Hawkens, Chairman
ADMINISTRATIVE JUDGE

/RA/

Dr. Michael F. Kennedy
ADMINISTRATIVE JUDGE

Rockville, Maryland
March 7, 2019

Judge Abreu, Concurring in Part, and Dissenting in Part

I. Introduction

While I agree with the majority's rulings on standing and, to a degree, contention admissibility as outlined in section III below, I must dissent from an important aspect of their contention admissibility findings because I respectfully disagree with their opinion that 10 C.F.R. § 51.53(c)(3) applies to subsequent license renewal. The plain language of the regulation states that it applies to an initial not a subsequent renewal. The APA requires a regulation adopted through notice and comment to be amended through notice and comment. Especially here, where the majority's application of the regulation creates both a significant uncertainty about what regulatory standards are applicable and an obstacle to a petitioner's ability to know how to properly frame its contentions, proper notice is essential. Although the agency's approach to subsequent license renewals may have evolved since section 51.53(c)(3) was proposed in 1991, to use that evolution as an excuse for an adjudicatory body to de facto change the regulation would subvert the intent of the APA and potentially risk the agency's credibility as to the openness, clarity, and reliability of its regulations—three of the agency's "Principles of Good Regulation."[1]

II. Analysis of Section 51.53(c)(3)

FPL and the Staff ask us to ignore the plain language of section 51.53(c)(3) because, they claim, it does not reflect the Commission's intent. They would have us ignore the word "initial" and apply the rule to subsequent license renewal applications because, as FPL and the Staff assert, reading the regulation in accordance with its plain language leads to an "absurd" result.[2] The majority likewise frames the issue before us as a "question of Commission intent"

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1 See NRC Principles of Good Regulation (ADAMS Accession No. ML14135A076).

2 FPL Surreply at 4; NRC Staff Response to FPL Surreply at 1–2.

and concludes that the Commission intended section 51.53(c)(3) to apply to all license renewal applications.[3] But the majority delves too deeply to find its answer. The regulation is clear on its face, and reading it in accordance with its plain language presents no absurdity or conflict with the agency's regulatory structure. Therefore, neither the Board nor the Commission has the authority to effectively amend a regulation to reflect new Commission "intent" outside of the notice and comment process.[4] When presented with an unambiguous regulation, an agency may not, "under the guise of interpreting [that] regulation, . . . create de facto a new regulation."[5] Because the NRC promulgated section 51.53(c)(3) through notice-and-comment rulemaking, it must use the same procedure if it wants to amend or repeal the rule.[6]

The "interpretation of any regulation must begin with the language and structure of the provision itself."[7] Contrary to the majority's characterization,[8] section 51.53(c)(3) is not "silent" as to its scope. The regulation is quite specific, and we must give all of its words full effect.[9] It applies to applicants: (1) seeking an "initial renewed license"; and (2) holding an operating

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[3] Majority at 13.

[4] See Conn. Nat'l Bank v. Germain, 503 U.S. 249, 253–54 (1992) ("[C]ourts must presume that a legislature says in a statute what it means and means in a statute what it says . . . . When the words of a statute are unambiguous, . . . 'judicial inquiry is complete.'" (quoting Rubin v. United States, 449 U.S. 424, 430 (1981))).

[5] Christensen v. Harris Cty., 529 U.S. 576, 588 (2000).

[6] See Perez v. Mortg. Bankers Ass'n, 575 U.S. __, 135 S. Ct. 1199, 1206 (2015) (citing FCC v. Fox Television Stations, Inc., 556 U.S. 502, 515 (2009)) (describing the APA's "mandate that agencies use the same procedures when they amend or repeal a rule as they used to issue the rule in the first instance").

[7] Long Island Lighting Co. (Shoreham Nuclear Power Station, Unit 1), ALAB-900, 28 NRC 275, 288 (1988).

[8] Majority at 15.

[9] Shoreham, ALAB-900, 28 NRC at 288.

license, construction permit, or combined license issued as of June 30, 1995.[10] These applicants must include in their environmental reports the information described in 10 C.F.R. § 51.53(c)(2), along with various "conditions and considerations" that, among other things, allow them to take advantage of the generic determinations in the GEIS for Category 1 environmental issues.[11] "[T]he admitted rules of statutory construction declare that a legislature is presumed to have used no superfluous words. Courts are to accord a meaning, if possible, to every word in a statute."[12] The oft-used principle, "expressio unius est exclusio alterius" (that is, the mention of one thing is the exclusion of the other), is instructive here.[13] Of the categories of license renewal applicants, the Commission chose "initial," thus implying that this was done to the exclusion of "subsequent."[14] Had the Commission meant "initial and subsequent," it could have said just that, or "initial" simply could have been deleted.

The majority relies on Federal Express Corp. v. Holowecki to support its approach to discerning the Commission's intent regarding the scope of section 51.53(c)(3).[15] But unlike here, Holowecki involved a statute and implementing regulations whose language left some

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[10] 10 C.F.R. § 51.53(c)(3) (emphasis added).

[11] Id.

[12] Platt v. Union Pac. R.R. Co., 99 U.S. 48, 58 (1878).

[13] See, e.g., Christensen, 529 U.S. at 582–83.

[14] The force of the "expressio unius" principle depends on context; the analysis "will turn on whether, looking at the structure of the statute and perhaps its legislative history, one can be confident that a normal draftsman when he expressed 'the one thing' would have likely considered the alternatives that are arguably precluded." Shook v. D.C. Fin. Responsibility & Mgmt. Assistance Auth., 132 F.3d 775, 782 (D.C. Cir. 1998). As discussed below, "initial," by definition, necessarily precludes "subsequent," and the regulatory history further supports its preclusive effect. Therefore, based on context, it is fair to say that the Commission, in choosing to include the word "initial," considered but nevertheless excluded all other alternatives. See id.

[15] See Majority at 15.

room for interpretation: what constitutes a "charge" when alleging unlawful age discrimination.[16] Here, using the word "initial" by definition limits the regulation's scope. Something is either "initial," i.e., first, or it is not.[17] No room exists for anything else.

Resorting to regulatory history is unnecessary when the meaning of a regulation is clear.[18] But even so, the regulatory history here supports an interpretation of the word "initial" as a limitation on the application of section 51.53(c)(3). In the Statements of Consideration for the 1991 proposed rule, the NRC anticipated that a licensee might file multiple license renewal applications, but nevertheless limited application of the efficiencies to be gained by the Part 51 amendments. The NRC stated that the safety considerations for license renewal application reviews outlined in Part 54 "could be applied to multiple renewals of an operating license for various increments," but in the very next sentence stated that the environmental considerations in the Part 51 amendments would apply only "to one renewal of the initial license for up to 20 years beyond [its] expiration."[19] This history of the Part 51 amendments demonstrates that the word "initial" in section 51.53(c)(3) was used with forethought. In 1991, the agency intended the Part 51 amendments for license renewal reviews to apply to one renewal, not multiple renewals.

When the final rule was promulgated in 1996, the Statements of Consideration analyzed the comments received and explained major changes in response to those comments—for example, the agency's decision to prepare a supplemental environmental impact statement for

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16 Fed. Express Corp. v. Holowecki, 552 U.S. 389, 393 (2008).

17 Initial, MERRIAM-WEBSTER'S COLLEGIATE DICTIONARY (10th ed. 1993) (defining "initial" to mean "of or relating to the beginning . . . placed at the beginning: first").

18 See, e.g., Conn. Nat'l Bank, 503 U.S. at 253–54.

19 Proposed Rule, Environmental Review for Renewal of Operating Licenses, 56 Fed. Reg. 47,016, 47,017 (Sept. 17, 1991) (emphasis added) [hereinafter 1991 Proposed Rule].

each license renewal application, rather than an environmental assessment.[20] The NRC did not repeat the "one-renewal" rationale, but to do so was not necessary; no comments about the one-renewal limitation on Part 51 were reported.[21] And the NRC reaffirmed that the changes in the final rule, while substantial, did not alter "the generic approach and scope" of the 1991 proposed rule.[22] Significantly, the final rule retained the word "initial" in section 51.53(c)(3).[23] Moreover, despite several changes to Part 51 since 1996, including changes to section 51.53(c)(3), "initial" remains in the rule to this day.[24]

Notably, in the 2009 proposed rule that accompanied the agency's proposed revisions to the GEIS, the NRC repeated the scope of section 51.53(c)(3) in the Statements of Consideration, explaining that it applies to "initial license renewal."[25] This slight phrasal change

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[20] See Final Rule, Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, 61 Fed. Reg. 28,467, 28,468 (June 5, 1996) [hereinafter 1996 Final Rule].

[21] See generally "Public Comments on the Proposed 10 CFR Part 51 Rule for Renewal of Nuclear Power Plant Operating Licenses and Supporting Documents: Review of Concerns and NRC Staff Response," NUREG-1529, vols. 1 & 2 (May 1996) (ADAMS Accession No. ML16362A344 (package)).

[22] 1996 Final Rule, 61 Fed. Reg. at 28,468.

[23] See id. at 28,487.

[24] See generally Final Rule, Miscellaneous Corrections, 79 Fed. Reg. 66,598 (Nov. 10, 2014) (making minor revisions for clarity and to correct typographical errors) [hereinafter Final Rule, Miscellaneous Corrections]; Final Rule, Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, 78 Fed. Reg. 37,282 (June 20, 2013) (updating the number and scope of the environmental issues to be addressed in license renewal proceedings consistent with the revised GEIS); Final Rule, Licenses, Certifications, and Approvals for Nuclear Power Plants, 72 Fed Reg. 49,352, 49,432 (Aug. 28, 2007) (adding "combined licenses" to section 51.53(c)(3)) [hereinafter Final Rule, Licenses, Certifications, and Approvals]; Final Rule, Changes to Requirements for Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, 64 Fed. Reg. 48,496 (Sept. 3, 1999) (expanding generic findings regarding transportation of spent fuel and waste); Final Rule, Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, 61 Fed. Reg. 66,537 (Dec. 18, 1996) (making "minor clarifying and conforming changes and add[ing] language inadvertently omitted from Table B-1" of the 1996 final rule).

[25] Proposed Rule, Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, 74 Fed. Reg. 38,117, 38,128 (July 31, 2009).

from the rule's text (i.e., "initial renewed license") demonstrates the agency's awareness of the rule's scope, revealing much more than would a rote copy-and-paste, and shows that the rule means what it says: it applies to "initial license renewal," not to "any" renewal.[26]

It is quite a stretch to interpret the agency's failure to repeat the "one-renewal" rationale for Part 51 in the 1996 Statements of Consideration as signaling a complete abandonment of its original position. Nor does it make sense to further assume that retention of the word "initial" in the final rule was a mere ministerial error. Rather, it makes far more sense to assume that the agency meant what it said originally. Had the NRC abandoned its one-renewal limit on the 1991 Part 51 amendments without expressly explaining why, the agency's action would have been subject to challenge as "arbitrary and capricious."[27] And even if we assume that the word "initial" had been retained by mistake for several years, the Commission could have, and still could, fix the error with the same notice process it has used with past Part 51 changes.[28]

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[26] Despite this, the majority maintains that there is "nothing in the regulatory history indicating that the scope of section 51.53(c)(3)—in 1996 or thereafter—was intended to be restricted to initial license renewals," Majority at 16 n.33, and avoids mentioning that nothing in the post-1996 regulatory history directly indicates that the regulation applies to subsequent license renewal. Moreover, the majority's observation is off target. Because the rule's stated application only to initial license renewals is unchanged to this day, the relevant regulatory history is the expressed intent when the rule was promulgated.

[27] See 5 U.S.C. § 706(2)(A).

[28] See, e.g., Final Rule, Miscellaneous Corrections, 79 Fed. Reg. at 66,600 (direct final rule; good cause found to waive notice and comment). If, as the majority asserts, the 1996 final rule's lack of mention of section 51.53(c)(3)'s "initial" qualifier shows intent not to limit the application of this regulation to one renewal, then why wasn't 51.53(c)(3) changed to reflect that intent in one of the several amendments that were made since 1996? See Majority at 16. Even if the lack of change was a simple oversight, the proper way to correct that oversight is through rulemaking. While the agency could try to justify a "good cause" waiver of the notice requirements in 5 U.S.C. § 553 for a quick fix to the rule, see 5 U.S.C. § 553(b)(3)(B), in my view, removing "initial" would have a substantive impact on subsequent license renewal applicants and hearing petitioners, thus requiring notice-and-comment rulemaking, but that is for the agency to decide.

FPL and the Staff can conceive of no reason why the Commission might place a limit on the use of the GEIS determinations in the environmental report beyond one renewal of a power reactor license.[29] Similarly, the majority finds that reading the rule consistent with its plain language would "undermine the regulatory purpose" of injecting efficiencies into the license renewal process.[30] But limiting the use of the rule for preparation of environmental reports to one license renewal was not an unreasonable approach for the agency to take, considering its obligations under NEPA. The Commission has recognized "the NRC's continuing duty to take a 'hard look' at new and significant information for each 'major federal action' to be taken."[31] So the agency reasonably could have determined that after a certain point—here, following the term of the initial license plus twenty years—the environmental impacts of license renewal should be considered afresh in the environmental report. The GEIS (in its original and revised form) bears this out. As Petitioners point out, references throughout the GEIS indicate that it contemplates only the forty-year term of the original license plus twenty years, for a total of sixty years—not the eighty or more years allowed for subsequent license renewal.[32] Of note, as part of the discussion of severe accidents, the revised GEIS expressly states that "the revision only

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29 See FPL Surreply at 4, 9–10; NRC Staff Response to FPL Surreply at 11–13.

30 Majority at 18.

31 Exelon Generation Co., LLC (Limerick Generating Station, Units 1 and 2), CLI-13-7, 78 NRC 199, 216 (2013) (quoting Marsh v. Or. Nat. Res. Council, 490 U.S. 360, 374 (1989)).

32 See Pet'rs. Response to FPL Surreply at 5–8. As its discussion makes clear, see Majority at 18–19, the majority basically accepts FPL's argument that "[t]he Commission's decision to retain the 10-year GEIS review and update provision in its 2013 revisions to Part 51 would make no sense if it had intended for the GEIS and Table B-1 to apply only to initial operating license renewals." FPL Surreply at 6. But the fact that the Commission expressed an intent to update the GEIS periodically in no way means that the GEIS analyses cover the temporal scope of a subsequent license renewal. Rather it simply means that when the GEIS is used the information it contains is reasonably up-to-date. Certainly, an applicant may reference the GEIS to make preparation of its environmental report more efficient, but it may not use section 51.53(c)(3)'s protections until the regulation is updated to include subsequent license renewals.

covers one initial license renewal period for each plant (as did the 1996 GEIS)," confirming that both the revised and the original GEIS look only at the temporal period of one license renewal.[33]

FPL and the Staff nonetheless assert, and the majority agrees, that the plain language of section 51.53(c)(3), with its use of the word "initial" in the environmental report instructions, cannot be reconciled with the rules governing the preparation of an environmental impact statement in sections 51.71(d), 51.95(c), and 10 C.F.R. Part 51, Subpart A, Appendix B, which refer generally to license renewal.[34] FPL and the Staff argue that the Staff is required to incorporate information from the GEIS for Category 1 issues for all power plant license renewal applications, initial and subsequent.[35] But the more general reference to license renewal in sections 51.95 and 10 C.F.R. Part 51, Subpart A, Appendix B dates to the 1991 proposed rule when the NRC explained that the "[P]art 51 amendments apply to one renewal of the initial license for up to 20 years."[36] And the 1996 final rule included 10 C.F.R. § 51.71(d) and the general reference to the "license renewal" stage, but within the context of a rule that retained the same "generic approach and scope" of the proposed rule.[37] The use of the plural to describe the amendments to Part 51 as a whole, not just section 51.53(c)(3), is telling. Therefore, if one wanted to resort to regulatory history, as the majority does, to reconcile the language of these sections in a manner consistent with each other, the word "initial" would need to be read into sections 51.71(d), 51.95(c), and 10 C.F.R. Part 51, Subpart A, Appendix B, rather than out of

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33 2013 GEIS at E-2.

34 See FPL Surreply at 7–9; NRC Staff Response to FPL Surreply at 16–19; Majority at 17–18 & n.35.

35 See FPL Surreply at 8–9; NRC Staff Response to FPL Surreply at 16–17.

36 1991 Proposed Rule, 56 Fed. Reg. at 47,017 (emphasis added); see also id. at 47,029.

37 1996 Final Rule, 61 Fed. Reg. at 28,468.

section 51.53(c)(3), as the majority effectively suggests, even though that is not the outcome they seek.[38]

The Staff further argues that section 51.53(c)(3) must apply to subsequent license renewal applications, notwithstanding the word "initial," because "the Commission has not promulgated any other requirements that specifically apply to an environmental report submitted for [a subsequent license renewal application]."[39] But this is not really an issue.[40] Applicants seeking a subsequent license renewal still must meet the requirements in 10 C.F.R. § 51.53(c)(1) and (c)(2). Section 51.53(c)(2) requires a license renewal applicant to include in the environmental report a description of the proposed action, a detailed description of the "affected environment around the plant," "the modifications directly affecting the environment or any plant effluents, and any planned refurbishment activities," as well as "the environmental impacts of alternatives and any other matters described in [10 C.F.R.] § 51.45."[41] Section 51.45, in turn, provides general requirements for environmental reports, with the exception, cross-referenced as section 51.53(c) and reflected in section 51.53(c)(2), that license renewal

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38 See 1991 Proposed Rule, 56 Fed. Reg. at 47,017. Further, section 51.53(c)(3)'s greater specificity, that it applies only to initial renewal, rather than any renewal, is an indicator that "initial" should not be ignored. "Ordinarily, where a specific provision conflicts with a general one, the specific governs." Edmond v. United States, 520 U.S. 651, 657 (1997) (citing Busic v. United States, 446 U.S. 398, 406 (1980)); see also Union of Concerned Scientists v. NRC, 711 F.2d 370, 381 (D.C. Cir. 1983) (determining that between the general provisions in the APA and the more specific requirements in the Atomic Energy Act, the Atomic Energy Act controls). To be clear, I do not advocate that "initial" should now be read into other sections of Part 51. I am simply saying that the 1991 proposed regulations had inconsistencies. Given that, we must look at the plain language, which is supported by the Statements of Consideration, for the foundation of the interpretation of section 51.53(c)(3), regardless of the inconsistencies. These inconsistencies must be addressed through rulemaking.

39 NRC Staff Response to FPL Surreply at 10 (emphasis omitted).

40 And if it were an issue, the agency would need to promulgate regulations through the rulemaking process.

41 10 C.F.R. § 51.53(c)(2).

environmental reports "need not discuss the economic or technical benefits and costs of either the proposed action or alternatives except if these benefits and costs are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation."[42] Sections 51.53(c)(1) and (c)(2), together with the cross-reference to the general requirements in section 51.45, thus would seem to ensure that sufficient information is available to aid the Staff in the development of an environmental impact statement, which as the majority notes, is the intended purpose of an environmental report.[43]

Even if applying the plain language of section 51.53(c)(3) may be inefficient in some instances, applying the regulation as written is not what produces a "discordant," "untenable," or even an "absurd" result, as the majority asserts.[44] Instead, what has created this inefficiency is the agency's change of policy without a parallel change to the implementing regulation. As discussed above, the agency made the conscious policy decision to limit the use of the Part 51 amendments to one renewal per reactor unit when the rule was proposed in 1991, which was not changed in the 1996 final rule. But if the agency now finds this policy objectionable or inefficient, we are not the ones to provide a remedy in this adjudication. When faced with a similar choice in Griffin v. Oceanic Contractors, the Court declined to ignore the plain language of a statute, observing that it has "refus[ed] to nullify statutes, however hard or unexpected the particular effect."[45] The Court further reasoned that "'[l]aws enacted with good intention, when put to the test, frequently, and to the surprise of the law maker himself, turn out to be

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[42] Id. § 51.45(c); see also id. § 51.53(c)(2).

[43] See Majority at 17–18.

[44] Id. at 24–25.

[45] 458 U.S. 564, 575 (1982) (holding under terms of statute, district court was required to impose $300,000 penalty on ship owner for failing, without good cause, to promptly pay a seaman $412.50 in earned wages).

mischievous, absurd or otherwise objectionable. But in such case, the remedy lies with the law making authority, and not with the courts.'"[46]

Just as the "remedy for . . . dissatisfaction with the results [of applying the plain language of a statute] lies with Congress, and not with th[e] Court," the remedy for dissatisfaction with the results of applying section 51.53(c)(3) according to its plain text lies with the NRC in its rulemaking authority, not the Board.[47] If the Commission wishes to abandon its "initial renewal" provision, it has a clear path to do so: the NRC must amend the regulation the same way in which the regulation was adopted—through the rulemaking process.[48]

FPL and the Staff also claim, and the majority agrees, that the Staff Requirements Memorandum for SECY-14-0016 compels an interpretation of the regulations that would require use of the GEIS determinations when preparing the environmental report in subsequent license renewal proceedings.[49] This argument fails for two reasons. First, the documents associated with the Commission's action on SECY-14-0016 do not support such an interpretation. Although the Staff, in its paper, discussed its activities relative to the environmental impacts of license renewal, the Staff dismissed the need to amend Part 51 in a single sentence, stating that it "does not recommend updating the environmental regulatory framework under 10 [C.F.R.] Part 51 . . . because environmental issues can be adequately addressed by the existing GEIS and through future GEIS revisions."[50] At the same time, the options laid out for Commission

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46 Id. (citation omitted).

47 Id. at 576.

48 See Mortg. Bankers, 575 U.S. at __, 135 S. Ct. at 1206.

49 See Majority at 20; FPL Surreply at 12–14; NRC Staff Response to FPL Surreply at 10–11, 13.

50 "Ongoing Staff Activities to Assess Regulatory Considerations for Power Reactor Subsequent License Renewal," Commission Paper SECY-14-0016 (Jan. 31, 2014) at 5, encl. 1 (ADAMS Accession No. ML14050A306) [hereinafter SECY-14-0016]. A common-sense view of how we got to this point is that the word "initial" in 51.53(c)(3) has simply been overlooked when

action in the Staff's paper, as well as the Staff's recommended option, all pertained to safety concerns.[51] And the voting record for SECY-14-0016 reflects that the Commission was responding to the safety aspects of subsequent license renewal and whether changes should be made to 10 C.F.R. Part 54, rather than any potential changes to the environmental regulations in Part 51.[52]

Second, even were we to assume that the Staff Requirements Memorandum for SECY-14-0016 implies a Commission determination that no change to Part 51 was necessary because the rules and the GEIS already applied to subsequent license renewal, neither the Commission's nor the Staff's interpretation is sufficient to amend section 51.53(c)(3).[53] FPL and

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Part 51 has been reviewed the past several years while the requirements for subsequent license renewal were being considered. If not this, then how else could the Staff tell the Commissioners in this SECY paper that updating Part 51 is not recommended? But just because "initial' has been overlooked, this does not give the Board authority to change its meaning to what the Staff wants today.

[51] SECY-14-0016, at 1–2, 5–9.

[52] See Commission Voting Record, "SECY-14-0016—Ongoing Staff Activities to Assess Regulatory Considerations for Power Reactor Subsequent License Renewal" (Aug. 29, 2014) (ADAMS Accession No. ML14245A118). Rather than approving anything, the Commission disapproved the Staff's recommendation to initiate a rulemaking pertaining to Part 54. Staff Requirements—SECY-14-0016—Ongoing Staff Activities to Assess Regulatory Considerations for Power Reactor Subsequent License Renewal (Aug. 29, 2014) (Adams Accession No. ML14241A578) [hereinafter SRM-SECY-14-0016].

Also, it seems strange that these distinctly amorphous circumstances are the best evidence of Commission intent FPL and the Staff (and the majority) can point to in the context of what is apparently the last instance in which the Commission dealt with the rule provisions in question. Given its obvious significance, if the Commission had been fully aware of this section 51.53(c)(3) issue, surely some definitive indication of the Commission's "intent" would have been expressed. Perhaps the first opportunity the Commission may actually have to directly express its "intent" on this subject may be in response to this Board's referred ruling on this issue. See 10 C.F.R. § 2.323(f)(1).

[53] See, e.g., Christensen, 529 U.S. at 588 (declining to defer to an agency interpretation that conflicted with an unambiguous regulation because to do so "would be to permit the agency, under the guise of interpreting a regulation, to create de facto a new regulation"). The same rationale applies to FPL's reference to the July 2018 status report the agency sent to the U.S. Senate Committee on Environment and Public Works, which FPL claims demonstrates "that the Commission views the current Part 51 regulatory framework," including the GEIS, "as

the Staff argue that we should accept their interpretation of section 51.53(c)(3) because to do otherwise would lead to an "absurd result." But it is far more absurd to read out of the regulation a word that has been retained over the course of several years and that was the product of a rulemaking involving broad public participation, including public meetings and workshops, at the time it was adopted.[54] Nor do we have the authority to do so.

Although the Commission has not issued a formal statement directly addressing the issue before us, such an interpretive rule would also put the agency at risk. As the Court has cautioned, "when an agency's decision to issue an interpretive rule, rather than a legislative rule, is driven primarily by a desire to skirt notice-and-comment provisions," the agency may be challenged under the "arbitrary and capricious standard."[55] Under the APA, an agency must "provide more substantial justification when 'its new policy rests upon factual findings that contradict those which underlay its prior policy; or when its prior policy has engendered serious reliance interests [in the written regulation] that must be taken into account. It would be arbitrary and capricious to ignore such matters.'"[56]

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applicable to [subsequent license renewal applications]." FPL Surreply at 14–15. Even assuming the status report is an expression of that intent, the report to Congress would not be enough to overcome the plain language of section 51.53(c)(3). See Christensen, 529 U.S. at 588.

54 See 1996 Final Rule, 61 Fed. Reg. at 28,469 (describing several public meetings and workshops over a rulemaking history spanning almost ten years). The majority describes a hypothetical that "would result in the wasteful expenditure of private and governmental resources." Majority at 25. This brings to mind TVA v. Hill, in which use of a federally funded multi-million-dollar dam project was halted to protect a small fish. Although not operating the dam similarly could have been described as a "wasteful expenditure," the Court declined to use such an excuse to go beyond the plain meaning of the Endangered Species Act. 437 U.S. 153, 187 (1978). Congress thereafter passed legislation to exempt the dam from the Endangered Species Act so that the dam could operate. See Pub. L. No. 96-69, 93 Stat. 437, 449–50 (1979). The legislature fixed the problem it created, rather than the Court.

55 Mortg. Bankers, 575 U.S. at __, 135 S. Ct. at 1209.

56 Id. (quoting Fox Television, 556 U.S. at 515).

Sidestepping the rulemaking process denies the public an opportunity to comment on a not-insignificant change to the NRC's regulations. And, in this case, that change would add another hurdle for petitioners. In past license renewal adjudicatory proceedings, a petitioner raising a challenge to a Category 1 issue had to meet the requirements for a waiver petition in 10 C.F.R. § 2.335, in addition to the contention admissibility requirements in 10 C.F.R. § 2.309, because such a contention would have been a challenge to the rule.[57] In those proceedings, however, applicants were seeking the initial renewal of their licenses, and therefore section 51.53(c)(3) plainly applied. To expect this case's petitioners to have sought a waiver of a regulation that does not clearly apply to this subsequent license renewal proceeding would be unfair.[58]

While I agree that the agency's current intent is to streamline the subsequent license renewal process, the agency has not amended 51.53(c)(3) to keep up with the evolved policy. The agency's expressed intent at the time the regulation was proposed was clearly that it applies only to initial license renewal. Looking to current intent while trying to explain away the expressed original intent of the regulation is a bridge too far. The agency's intent today may not be the same as the agency's intent when the regulation was created, but that original intent is what ultimately matters for regulatory interpretation. As the Appeal Board explained in the Shoreham proceeding, "[a]lthough administrative history and other available guidance may be consulted for background information and the resolution of ambiguities in a regulation's language, its interpretation may not conflict with the plain meaning of the wording used in that

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[57] See Exelon Generation Co., LLC (Limerick Generating Station, Units 1 and 2), CLI-12-19, 76 NRC 377, 384, 386 (2012); Entergy Nuclear Vermont Yankee, LLC (Vermont Yankee Nuclear Power Station), CLI-07-3, 65 NRC 13, 16 (2007); Florida Power & Light Co. (Turkey Point Nuclear Generating Plant, Units 3 and 4), CLI-01-17, 54 NRC 3, 22–23 (2001).

[58] Cf. Limerick, CLI-13-7, 78 NRC at 203 (offering a belated opportunity to submit a waiver petition after resolving "an apparent ambiguity in [the] license renewal regulations").

regulation."[59] The majority's tortuous approach to determining the regulation's applicability wipes away the plain meaning and the original regulatory intent, and instead skips to the Staff's more recent guidance documents and to the inconsistency the agency created when it did not update section 51.53(c)(3) to match that new intent.

The agency's new position clearly conflicts with the plain language of the rule, and we may not fix the problem in this adjudication.[60] To do so would run afoul of the APA and set a troubling precedent that might encourage the agency to take short cuts to amending its regulations in future adjudicatory proceedings. The majority points out the inefficiency of admitted contentions then becoming inadmissible if the regulations are applied as written,[61] but this inefficiency was created by the agency that is responsible for ensuring that the regulations are up-to-date. An agency may not create a situation that is inconsistent with an existing regulation and then use that disparity as an excuse to make a de facto amendment without notice and comment. For example, if the agency can change the meaning of "initial," what is to

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59 Shoreham, ALAB-900, 28 NRC at 288.

60 See "Standard Review Plan for Review of Subsequent License Renewal Applications for Nuclear Power Plants," NUREG-2192 at 1.1-2 (July 2017) (ADAMS Accession No. ML17188A158) (providing that the Staff reviewer will check that the applicant has prepared its environmental report "in accordance with the guidelines in NUREG–1555, 'Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal,'" which refers generally to license renewal applicants); accord "Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications," Reg. Guide 4.2 (supp. 1, rev. 1) (June 2013) (ADAMS Accession No. ML13067A354) (referring generally to "license renewal applications") [hereinafter Reg. Guide 4.2]. But see Reg. Guide 4.2 at 33 (guiding the applicant to show the relationships between plant operation and resource attributes, and "[i]f any adverse impacts are identified," guiding the applicant to describe "the mitigation measures that have been used to reduce the adverse impacts during the initial license period or that are expected to be used during the license renewal period and their expected effects") (emphasis added)).

61 Majority at 24–25.

stop it from changing the June 30, 1995, limitation in section 51.53(c)(3) without notice and comment?[62]

If the NRC truly wants section 51.53(c)(3) to apply to subsequent license renewals, it must amend its regulations via the rulemaking process. Until that is completed, a short-term solution might be for the NRC to allow FPL and similarly situated subsequent license renewal applicants the option to reference the information in the GEIS for Category 1 issues in their environmental reports (rather than generating that information anew), thus gaining the procedural efficiencies that the Staff and the Commission may desire for subsequent license renewal.[63] But until section 51.53(c)(3) is revised to include subsequent license renewal

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62 The NRC might again be presented with a need to amend section 51.53(c)(3) when the time comes for a combined license holder to seek a renewed license. Although the agency amended the regulation in 2007 to include "combined licenses," section 51.53(c)(3) is limited to license holders as of "June 30, 1995," at which time no combined license had been issued, thereby precluding its use for those licensees. See Final Rule, Licenses, Certifications, and Approvals, 72 Fed. Reg. at 49,432, 49,513; Southern Nuclear Operating Co. (Vogtle Electric Generating Plant, Units 3 and 4), CLI-12-2, 75 NRC 63, 122 (2012) (authorizing issuance of the first combined licenses). The "June 30, 1995," restriction also appears in Part 51, Subpart A, Appendix B, but this appendix does not include combined licenses among the types of licenses that may be renewed using the GEIS-associated efficiencies in the rule.

63 Applicants for subsequent license renewal still retain the efficiencies accorded under Part 54, as contemplated in the original rulemaking and reaffirmed by the Commission in SECY-14-0016. See, e.g., 1991 Proposed Rule at 47,017 ("The [P]art 54 rule could be applied to multiple renewals of an operating license for various increments."); SRM-SECY-14-0016 (disapproving the Staff's recommendation to initiate a rulemaking to amend Part 54 for power reactor subsequent license renewal). I recognize that in the long run, the outcome is not in question: section 51.53(c)(3) will end up applying to any renewal, either because the Commission upholds the majority's decision or because the agency changes the regulation via the notice-and-comment process. The real issue is what road the Commission takes to get there. And given the short-term solution proposed above, no immediacy exists here that might counsel in favor of taking action outside the rulemaking process and risking an APA violation. In the interim, the Staff has the option of incorporating information from the GEIS in the supplemental environmental impact statement. But given that there is some question as to whether the GEIS contemplates the temporal scope of subsequent license renewal, see supra Dissent notes 32–33 and accompanying text, the Staff should ensure that its environmental review of subsequent license renewal applications is sufficiently forward-looking. Cf. New York v. NRC, 681 F.3d 471, 478–79, 483 (D.C. Cir. 2012) ("[A] generic analysis must be forward looking and have enough breadth to support the Commission's conclusions."), and petition for review denied, 824 F.3d 1012 (D.C. Cir. 2016).

applicants, petitioners must be allowed to challenge the substantive viability of any GEIS analyses incorporated by reference, without having to request a section 2.335 waiver, provided that they meet the standards for intervention in section 2.309. Requiring petitioners to meet only the contention admissibility standards would not shift the burden, as FPL would have it,[64] but instead maintains the status quo, given that contentions challenging environmental report Category 1 issues in subsequent license renewal proceedings do not challenge the regulations as currently written.[65]

III. Standing and Contention Admissibility

I concur with the majority's rulings on standing for SACE and the Joint Petitioners and on the admission of limited portions of contentions related to the discussion of the cooling tower alternative, the effects on the American crocodile, the source of surface water ammonia, and the impacts of ammonia discharges.[66] I concur with the majority not to admit all other contentions, or portions of contentions, whose inadmissibility was based on reasons that did not include the need for a section 2.335 waiver.

I also concur with allowing Monroe County to join as an interested government participant regarding SACE's two admitted contentions. And finally, I concur in the majority's determination to refer its ruling on the section 51.53(c)(3) matter to the Commission pursuant to 10 C.F.R. § 2.323(f)(1).

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64 See Tr. at 65–66.

65 By the same token, if any admitted contentions challenging Category 1 issues were outstanding if and when a rulemaking change to section 51.53(c)(3) becomes effective (thus precluding Category 1 items from being subject to adjudicatory consideration in a subsequent license renewal proceeding), the sponsors of those contentions should be afforded a reasonable opportunity, in accordance with section 2.335(b), to submit a rule waiver petition regarding the subject matter of those contentions.

66 Regarding the admission of ammonia-related issues, although section 51.53(c)(3)(ii)(E) is referenced, the Joint Petitioners also noted that if section 51.53(c)(3) does not apply to subsequent license renewal applications, section 51.53(c)(1) and (c)(2) (along with section 51.45) apply in the alternative. Joint Pet'rs Pet. at 16 n.71.

Relative to the contentions the majority has judged inadmissible due to, at least in part, the need for a section 2.335 waiver to challenge a Category 1 issue, I abstain from endorsing that result due to my conviction that section 51.53(c)(3), as written, cannot apply to subsequent license renewal applications.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
FLORIDA POWER & LIGHT COMPANY	)	Docket Nos. 50-250-SLR
	)	50-251-SLR
(Turkey Point Nuclear Generating Units 3 & 4)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing **MEMORANDUM AND ORDER (Granting the Hearing Requests of SACE and Joint Petitioners, Denying the Hearing Request of Albert Gomez, Granting Monroe County's Request to Participate as an Interested Governmental Participant, and Referring a Ruling to the Commission) (LBP-19-3)** have been served upon the following persons by Electronic Information Exchange and by electronic mail as indicated by an asterisk (*).

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Atomic Safety and Licensing Board Panel
U.S. Nuclear Regulatory Commission
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[Original signed by Clara Sola]
Office of the Secretary of the Commission

Dated at Rockville, Maryland,
this 7th day of March, 2019

(3150–XXXX), Attn: Desk Officer for the Nuclear Regulatory Commission, 725 17th Street NW, Washington, DC 20503; email: *oira_submission@omb.eop.gov.*

FOR FURTHER INFORMATION CONTACT: David Cullison, NRC Clearance Officer, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001; telephone: 301–415–2084; email: *Infocollects.Resource@nrc.gov.*

SUPPLEMENTARY INFORMATION:

I. Obtaining Information and Submitting Comments

A. Obtaining Information

Please refer to Docket ID NRC–2017–0060 when contacting the NRC about the availability of information for this action. You may obtain publicly-available information related to this action by any of the following methods:

• *Federal Rulemaking website:* Go to *http://www.regulations.gov* and search for Docket ID NRC–2017–0060. A copy of the collection of information and related instructions may be obtained without charge by accessing Docket ID NRC–2017–0060 on this website.

• *NRC's Agencywide Documents Access and Management System (ADAMS):* You may obtain publicly-available documents online in the ADAMS Public Documents collection at *http://www.nrc.gov/reading-rm/adams.html.* To begin the search, select ''*ADAMS Public Documents*'' and then select ''*Begin Web-based ADAMS Search.*'' For problems with ADAMS, please contact the NRC's Public Document Room (PDR) reference staff at 1–800–397–4209, 301–415–4737, or by email to *pdr.resource@nrc.gov.* A copy of the collection of information and related instructions may be obtained without charge by accessing ADAMS Accession Nos: ML19057A161, ML19057A167, and ML19057A169. The supporting statement is available in ADAMS under Accession No. ML19057A101.

• *NRC's PDR:* You may examine and purchase copies of public documents at the NRC's PDR, Room O1–F21, One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852.

• *NRC's Clearance Officer:* A copy of the collection of information and related instructions may be obtained without charge by contacting the NRC's Clearance Officer, David Cullison, Office of the Chief Information Officer, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001; telephone: 301–415–2084; email: *Infocollects.Resource@nrc.gov.*

B. Submitting Comments

The NRC cautions you not to include identifying or contact information in comment submissions that you do not want to be publicly disclosed in your comment submission. All comment submissions are posted at *http://www.regulations.gov* and entered into ADAMS. Comment submissions are not routinely edited to remove identifying or contact information.

If you are requesting or aggregating comments from other persons for submission to the OMB, then you should inform those persons not to include identifying or contact information that they do not want to be publicly disclosed in their comment submission. Your request should state that comment submissions are not routinely edited to remove such information before making the comment submissions available to the public or entering the comment into ADAMS.

II. Background

Under the provisions of the Paperwork Reduction Act of 1995 (44 U.S.C. Chapter 35), the NRC recently submitted a proposed collection of information to OMB for review entitled, ''NRC Form 361, Reactor Plant Event Notification Worksheet; NRC Form 361A, Fuel Cycle and Materials Event Notification Worksheet; NRC Form 361N, Non-Power Reactor Event Notification Worksheet.'' The NRC hereby informs potential respondents that an agency may not conduct or sponsor, and that a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

The NRC published a **Federal Register** notice with a 60-day comment period on this information collection on September 25, 2018 (83 FR 48472).

1. *The title of the information collection:* NRC Form 361, Reactor Plant Event Notification Worksheet, NRC Form 361A, Fuel Cycle and Materials Event Notification Worksheet; NRC Form 361N, Non-Power Reactor Event Notification Worksheet.''

2. *OMB approval number:* 3150–XXXX.

3. *Type of submission:* New.

4. *The form number if applicable:* NRC Form 361, NRC Form 361A, NRC Form 361N.

5. *How often the collection is required or requested:* On occasion, as defined, NRC licensee events are reportable when they occur.

6. *Who will be required or asked to respond:* Holders of NRC licenses for commercial nuclear power plants, fuel cycle facilities, NRC material licensees, and non-power reactors.

7. *The estimated number of annual responses:* 537.

8. *The estimated number of annual respondents:* 537.

9. *An estimate of the total number of hours needed annually to comply with the information collection requirement or request:* 268.5 hours.

10. *Abstract:* The NRC requires its licensees to report by telephone certain reactor events and emergencies that have potential impact to public health and safety. In order to efficiently process the information received through such reports for reactors, the NRC created Forms 361 to provide a templated worksheet for recording the information. NRC licensees are not required to fill out or submit the worksheet, but the form provides the usual order of questions and discussion to enable a licensee to prepare answers for a more clear and complete telephonic notification. Without the templated format of the NRC Forms 361, the information exchange between licensees and NRC Headquarters Operations Officers via telephone could result in delays as well as unnecessary transposition errors.

Dated at Rockville, Maryland, this 1st day of April 2019.

For the Nuclear Regulatory Commission.

David C. Cullison,

NRC Clearance Officer, Office of the Chief Information Officer.

[FR Doc. 2019–06550 Filed 4–3–19; 8:45 am]

BILLING CODE 7590–01–P

NUCLEAR REGULATORY COMMISSION

[Docket Nos. 50–250, 50–251; NRC–2018–0101]

Florida Power & Light Company; Turkey Point Nuclear Generating Unit Nos. 3 and 4

AGENCY: Nuclear Regulatory Commission.

ACTION: Draft supplemental environmental impact statement; request for comment.

SUMMARY: The U.S. Nuclear Regulatory Commission (NRC) is issuing for public comment draft plant-specific Supplement 5, Second Renewal, to the Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants, NUREG–1437, regarding the subsequent renewal of Facility Operating License Nos. DPR–31 and DPR–41 for an additional 20 years of operation for Turkey Point Nuclear Generating Unit Nos. 3 and 4 (Turkey Point). The Turkey Point facility is

located in Miami-Dade County, Florida. Possible alternatives to the proposed action (subsequent license renewal) include no action and reasonable replacement power and cooling water system alternatives.

DATES: Submit comments by May 20, 2019. Comments received after this date will be considered, if it is practical to do so, but the NRC is able to ensure consideration only for comments received on or before this date.

ADDRESSES: You may submit comments by any of the following methods:

- *Federal Rulemaking Website:* Go to *http://www.regulations.gov* and search for Docket ID NRC–2018–0101. Address questions about NRC dockets to Jennifer Borges; telephone: 301 287–9127; email: *Jennifer.Borges@nrc.gov.* For technical questions, contact the individual listed in the **FOR FURTHER INFORMATION CONTACT** section of this document.
- *Mail comments to:* Office of Administration, Mail Stop: TWFN–7–A60M, ATTN: Program Management, Announcements and Editing Staff, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001.
- *Email comments to: TurkeyPoint34SLREIS.Resource@nrc.gov*

For additional direction on obtaining information and submitting comments, see ''Obtaining Information and Submitting Comments'' in the **SUPPLEMENTARY INFORMATION** section of this document.

FOR FURTHER INFORMATION CONTACT: David Drucker, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001; telephone: 301–415–6223; email: *David.Drucker@nrc.gov.*

SUPPLEMENTARY INFORMATION:

I. Obtaining Information and Submitting Comments

A. Obtaining Information

Please refer to Docket ID NRC–2018–0101 when contacting the NRC about the availability of information regarding this document. You may obtain publicly-available information related to this document by any of the following methods:

- *Federal Rulemaking Website:* Go to *http://www.regulations.gov* and search for Docket ID NRC–2018–0101.
- *NRC's Agencywide Documents Access and Management System (ADAMS):* You may access publicly-available documents online in the ADAMS Public Documents collection at *http://www.nrc.gov/reading-rm/adams.html.* To begin the search, select ''*Begin Web-based ADAMS Search.*'' For problems with ADAMS, please contact the NRC's Public Document Room (PDR) reference staff at 1–800–397–4209, 301–415–4737, or by email to *pdr.resource@nrc.gov.* The ADAMS accession number for each document referenced in this document (if that document is available in ADAMS) is provided the first time that the document is referenced here. Draft plant-specific Supplement 5, Second Renewal, to the GEIS for License Renewal of Nuclear Plants, NUREG–1437, is available in ADAMS under Accession No. ML19078A330.
- *NRC's PDR:* You may examine and purchase copies of public documents at the NRC's PDR, Room O1–F21, One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852.
- *Library:* A copy of draft plant-specific Supplement 5, Second Renewal, to the GEIS for License Renewal of Nuclear Plants, NUREG–1437, is available at the following locations: Homestead Branch Library, 700 N. Homestead Blvd., Homestead, FL 33033; Naranja Branch Library, 14850 SW 280th St., Homestead, FL 33032; South Dade Regional Library, 10750 SW 211th St., Miami, FL 33189; and Downtown Miami Branch, 101 West Flagler St., Miami, FL 30130.

B. Submitting Comments

Please include Docket ID NRC–2018–0101 in the subject line of your comment submission, in order to ensure that the NRC is able to make your comment submission available to the public in this docket.

The NRC cautions you not to include identifying or contact information in comment submissions that you do not want to be publicly disclosed. The NRC will post all comment submissions at *http://www.regulations.gov* as well as enter the comment submissions into ADAMS. The NRC does not routinely edit comment submissions to remove identifying or contact information.

If you are requesting or aggregating comments from other persons for submission to the NRC, you should inform those persons not to include identifying or contact information that they do not want to be publicly disclosed in their comment submission. Your request should state that the NRC does not routinely edit comment submissions to remove such information before making the comment submissions available to the public or entering the comment into ADAMS.

II. Discussion

The NRC is issuing for public comment draft plant-specific Supplement 5, Second Renewal, to the GEIS for License Renewal of Nuclear Plants, NUREG–1437, regarding the subsequent renewal of Facility Operating License Nos. DPR–31 and DPR–41 for an additional 20 years of operation for Turkey Point Unit Nos. 3 and 4. Draft plant-specific Supplement 5, Second Renewal, to the GEIS includes the preliminary analysis that evaluates the environmental impacts of the proposed action and alternatives to the proposed action. The NRC's preliminary recommendation is that the adverse environmental impacts of subsequent license renewal for Turkey Point are not so great that preserving the option of subsequent license renewal for energy-planning decisionmakers would be unreasonable.

III. Public Meetings

The NRC staff will hold two public meetings prior to the close of the public comment period to present an overview of the draft plant-specific supplement to the GEIS and to accept public comment on the document. The meetings will be held on May 1, 2019, from 1:00 p.m. to 3:00 p.m. and from 6:00 p.m. to 8:00 p.m. at the City of Homestead City Hall, 100 Civic Court, Homestead, FL 33030. There will be an open house one hour before each meeting for members of the public to meet with NRC staff members and sign in to speak. The meetings will be transcribed and will include: (1) A presentation of the contents of the draft plant-specific supplement to the GEIS and (2) the opportunity for interested government agencies, organizations, and individuals to provide comments on the draft plant-specific supplement to the GEIS. To be considered in the final supplement to the GEIS, comments must be provided either at the transcribed public meetings or submitted in writing by the comment deadline identified above. Persons may pre-register to attend or present oral comments at the meetings by contacting Mr. William Burton, the NRC Project Manager, at 301–415–6332, or by email at *William.Burton@nrc.gov* no later than Tuesday, April 23, 2019. Members of the public may also register to provide oral comments within 15 minutes before the start of the meetings. Individual oral comments may be limited by the time available, depending on the number of persons who register. If special equipment or accommodations are needed to attend or present information at the public meeting, the need should be brought to Mr. Burton's attention no later than Tuesday, April 23, 2019, to provide the NRC staff adequate notice to determine whether the request can be accommodated.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	
FLORIDA POWER & LIGHT COMPANY	)	Docket No. 50-250-SLR
	)	Docket No. 50-251-SLR
(Turkey Point Nuclear Generating Station, Unit Nos. 3 and 4)	)	
	)	June 24, 2019
	)	

NATURAL RESOURCES DEFENSE COUNCIL'S, FRIENDS OF THE EARTH'S, AND MIAMI WATERKEEPER'S MOTION TO MIGRATE CONTENTIONS & ADMIT NEW CONTENTIONS IN RESPONSE TO NRC STAFF'S SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT

I. INTRODUCTION

Pursuant to 10 C.F.R. § 2.309(c) and the Atomic Safety and Licensing Board's ("Board") Revised Scheduling Order,[1] Natural Resources Defense Council, Friends of the Earth, and Miami Waterkeeper (together "Intervenors") hereby move for the migration and admission of amended and new contentions regarding the Draft Supplemental Environmental Impact Statement[2] ("DSEIS") for Florida Power and Light Company's ("Applicant") proposed subsequent license renewal issued by the Nuclear Regulatory Commission ("NRC" or "Commission") Staff in March 2019.

Intervenors respectfully submit the migration or amendment of previously admitted

[1] Order (Granting in Part Intervenor's Joint Motion for Partial Reconsideration of Initial Scheduling Order) (Apr. 2, 2019) (ML19092A386) (providing that the deadline for answer opposing a dispositive motion is 30 days after May 10, 2019) (hereinafter "Scheduling Order").

[2] NUREG-1437, Supp. 5, Second Renewal, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 5, Second Renewal, Regarding Subsequent License Renewal for Turkey Point Nuclear Generating Unit Nos. 3 and 4, Draft Report for Comment" (Mar. 2019) (ML19078A330) (hereinafter "DSEIS").

contentions (Contentions 1-E and 5-E) and respectfully request admission of four new contentions (Contentions 6-E, 7-E, 8-E, and 9-E). The migrated or amended contentions simply assert that the DSEIS fails either to address or to address adequately previously-identified omissions contained in the Applicant's Environmental Report.

The new contentions concern the NRC Staff's analysis of "new and significant" information for one existing Category 1 issue[3] – groundwater quality degradation (plants with cooling ponds in salt marshes), and one "new issue" – water quality impacts on adjacent water bodies (plants with cooling ponds in salt marshes).[4] Intervenors also move to admit new contentions based on information that was previously unavailable and which remain unaddressed in the DSEIS.[5] This new information demonstrates that several conclusions about environmental impacts in the DSEIS are unsupported by the evidence; particularly those conclusions that rely on Applicant's compliance with the 2015 Consent Agreement between Applicant and Miami-Dade County[6] and the 2016 Consent Order between Applicant and the Florida Department of Environmental Protection ("FDEP")[7] that govern "freshening" in the cooling canal system and

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[3] Generally, Category 1 issues are "beyond the scope of a license renewal hearing," unless a waiver is granted. *Florida Power & Light Co.* (Turkey Point Nuclear Generating Plant, Units 3 and 4), CLI-01-17, 54 NRC 3, 15 (July 19, 2001); 10 C.F.R. § 2.335(b). Intervenors do not believe a waiver is necessary here, but submit a waiver for the new contentions out of an abundance of caution. NRDC's, FOE's, and Miami Waterkeeper's Petition for Waiver of 10 C.F.R. §§ 51.53(C)(3) and 51.71(D) and 10 C.F.R. Part 51, Subpart A, Appendix B.

[4] DSEIS at 4-2.

[5] 10 C.F.R. § 2.309(c)(1).

[6] Miami-Dade County, "Consent Agreement Concerning Water Quality Impacts Associated with the Cooling Canal System at Turkey Point Power Plant" (Oct. 6, 2015) (ML16335A219) (referenced in DSEIS as MDC 2015a).

[7] Florida Department of Environmental Protection, "Consent Order, OGC File 13 Number 16-0241, between the State of Florida Department of Environmental Protection and 14 Florida Power & Light Company regarding settlement of Matters at Issue [Westward Migration of 15 Hypersaline Water from the Turkey Point Facility and Potential Releases to Deep Channels on 16 the Eastern and Southern Side of the Facility]" (June 20, 2016) (ML16216A12) (referenced in DSEIS as FDEP 2016e).

remediation of Applicant's hypersaline plume.[8]

II. BACKGROUND

A. Procedural Background

On August 1, 2018 and pursuant to 10 C.F.R. § 2.309 and the NRC's Federal Register notice published at 83 Fed. Reg. 19,304 (May 2, 2018), Intervenors submitted a Request for Hearing and Petition to Intervene[9] in the above-captioned matter. To safeguard our and our members' environmental, aesthetic, health-based and economic interests, Intervenors articulated five contentions in the Petition. These contentions addressed various deficiencies in Applicant's Environmental Report,[10] submitted as part of the subsequent renewal license application for Turkey Point Nuclear Generating Station, Units 3 and 4, in Miami-Dade County, Florida.

Following full briefing and a hearing on the admissibility of each contention, the Board on March 7, 2019 issued Memorandum and Order LBP-19-3 granting Intervenors' hearing request.[11] In that Order, the Board also found that Intervenors had established standing and admitted in part two of the five contentions. On March 19, 2019, Intervenors, Applicant, and the

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[8] *See, e.g.*, DSEIS at 4-23 ("[U]pon consideration of the FDEP's and DERM's existing requirements and their continuing oversight of FPL's site remediation efforts, the NRC staff concludes that the impacts on adjacent surface water bodies via the groundwater pathway from the [cooling canal system] during the subsequent license renewal term would be SMALL and, therefore, the new information that has been identified is not significant."); DSEIS at 4-27 ("[T]he NRC staff concludes that as a result of FPL's operation of its recovery well system and continued regulatory oversight and enforcement of the terms of the consent order and consent agreement by the FDEP and DERM, the impacts on groundwater quality from operations during the subsequent license renewal term would be SMALL."). DSEIS at 4-117 ("The NRC Staff expects that continued operation of the freshening system, combined with proper operation and maintenance of the [cooling canal system], will result in no substantial contribution to cumulative impacts on groundwater quality or associated impacts on surface water quality in Biscayne Bay during the subsequent license renewal period.").

[9] Request for Hearing and Petition to Intervene Submitted by Friends of the Earth, Natural Resources Defense Council, and Miami Waterkeeper (Aug. 1, 2018) (ML18212A418) ("Petition").

[10] Turkey Point Nuclear Plant, Units 3 and 4, Appendix E, Applicant's Environmental Report Subsequent Operating License Renewal Stage (Jan. 2018) (ML1813A145) (hereinafter "Environmental Report").

[11] *Fla. Power & Light Co.* (Turkey Point Nuclear Generating Station Units 3 & 4), LBP-19-3, 89 N.R.C. __ (slip op.) (Mar. 7, 2019) ("Order").

NRC Staff filed a joint motion regarding the hearing schedule, mandatory disclosures, and hearing file obligations in this proceeding.[12] The Board issued an Initial Scheduling Order that provided Intervenors the opportunity to review initial disclosures provided by the parties and then rely on them to file new and amended contentions.[13] Thereafter, at Intervenors' request the Board made modest changes to the Initial Scheduling Order that continued to allow Intervenors to rely on initial disclosures in the new and amended contentions, but also allowed Intervenors to rely on the same in opposing any dispositive motions.[14]

On April 1, 2019, Applicant filed an appeal of the Order,[15] and on April 26, 2019, Intervenors opposed the appeal.[16] The NRC Staff agreed with Intervenors that the Board had correctly admitted the contentions.[17] This appeal is pending before the Commission. In March 2019, NRC Staff issued the DSEIS. Based on the DSEIS, on May 20, 2019, Applicant filed two motions to dismiss Intervenors' contentions as moot.[18] On June 10, 2019, Intervenors opposed these motions,[19] and the NRC Staff supported them.[20] These motions are currently pending

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[12] Joint Motion Regarding Hearing Schedule, Mandatory Disclosures, and Hearing File Obligations (Mar. 19, 2019).

[13] Initial Scheduling Order at 3 (establishing the deadline to file new and amended contentions as 45 days following the later of the issuance of the DSEIS or the Initial Disclosures) (Mar. 21, 2019).

[14] Order (Granting in Part Intervenors' Joint Motion for Partial Reconsideration of Initial Scheduling Order) (Apr. 2, 2019).

[15] Florida Power & Light Company's Appeal of LBP-19-3 (Apr. 1, 2019) (ML19091A302) ("Appeal"). FPL did not challenge Petitioners' standing before the Commission.

[16] Opposition of Natural Resources Defense Council, Friends of the Earth, and Miami Waterkeeper to Florid Power & Light Company's Appeal of the Atomic Safety and Licensing Board's Ruling in LBP-19-3 (Apr. 26, 2019) (ML19116A229).

[17] NRC Staff's Brief in Response to Florida Power & Light Company's Appeal of LBO-19-3 (Apr. 26, 2019) (ML19116A272).

[18] FPL's Motion to Dismiss Joint Petitioners' Contention 1-E as Moot (May 20, 2019) (ML19140A355); FPL's Motion to Dismiss Joint Petitioners' Contention 5-E as Moot (May 20, 2019) (ML19140A356).

[19] Joint Petitioners' Answer Opposing FPL's Motion to Dismiss Joint Petitioners' Contention 1-E as Moot (June 10, 2019); Joint Petitioners' Answer Opposing FPL's Motion to Dismiss Joint Petitioners' Contention 5-E as Moot (June 10, 2019).

[20] NRC Staff's Answer to FPL's Motions to Dismiss (June 10, 2019).

before the Board.[21]

Intervenors timely filed comments on the DSEIS on May 20, 2019[22] and today timely file amended and new contentions based on the DSEIS.

B. <u>Legal Standards</u>

A license renewal application review typically implicates issues that fall into one of two broad areas: safety/aging management issues, and public health/environmental impacts. Petitioner's contentions are focused on environmental and public health impacts. The scope of the environmental review is defined by 10 C.F.R. Part 51, the NRC's "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," NUREG- 1437 (May 1996) (the "GEIS"), and the initial hearing notice and order.[23] Some environmental issues that might otherwise be germane in a license renewal proceeding have been resolved generically for all plants and are normally, therefore, "beyond the scope of a license renewal hearing."[24] These "Category 1" issues are classified in 10 C.F.R. Part 51, Subpart A, Appendix B. Category 1 issues may be raised when a petitioner (1) demonstrates that there is new and significant information subsequent to the preparation of the GEIS regarding the environmental impacts of license renewal; (2) files a petition for a rulemaking with the NRC; or (3) seeks a waiver pursuant to 10 C.F.R. § 2.335.[25]

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[21] If the Board finds that a contention is not moot, that contention should migrate. On the other hand, if the Board finds a contention is moot, then the contention should be amended.

[22] NRDC, FOE, and Miami Waterkeeper Comments on Draft Supplemental Environmental Impact Statement for Turkey Point Nuclear Generating Units Nos. 3 and 4 (May 20, 2019).

[23] *See, e.g., Entergy Nuclear Vermont Yankee, LLC* (Vermont Yankee Nuclear Power Station), LBP-06-20, 64 NRC 131, 148–49 (2006).

[24] *Florida Power & Light Co.* (Turkey Point Nuclear Generating Plant, Units 3 and 4), CLI-01-17, 54 NRC 3, 15 (July 19, 2001); *see* 10 C.F.R. § 51.53(c)(3)(i).

[25] *Turkey Point*, 54 NRC at 10-12; *see also* 10 C.F.R. § 51.53(c)(3)(iv) (new and significant information).

NRC regulations dictate that contentions arising pursuant to NEPA must initially be "based on the applicant's environmental report."[26] Once the NRC Staff has published its DSEIS, the Commission has explained that contentions originally challenging an environmental report automatically migrate to challenge the NRC Staff's DSEIS.[27] This so-called "migration tenet obviates the requirement to file the same contention (and litigate its admissibility) three times—once against the [Environmental Report], once against the DEIS, and once against the final environmental impact statement."[28] However, a contention may only migrate if the information in the subsequent DSEIS is "sufficiently similar to the information in the [Environmental Report]."[29]

If the information in the DSEIS is not sufficiently similar to what the contention challenged in the Environmental Report, an intervenor must file a motion to amend the admitted contention and/or to admit a new contention.[30] For example, a contention challenging an omission in the environmental report may not migrate to challenge the adequacy of new information or analysis provided in the DSEIS; the contention would need to be amended.[31] New and amended contentions are admissible as long as the intervenor demonstrates good cause by showing that the contention is supported by new information that (1) was not previously available; (2) is materially different from information that was previously available, and (3) is

[26] 10 C.F.R. § 2.309(f)(2).

[27] *See Private Fuel Storage, LLC* (Independent Spent Fuel Storage Installation), LBP-01-23, 54 NRC 163, 172 n.3 (2001); *see also La. Energy Servs., LP* (Claiborne Enrichment Center), CLI-98-3, 47 NRC 77, 84 (1998).

[28] *Progress Energy Fla., Inc*. (Levy County Nuclear Power Plant, Units 1 and 2), LBP-11-01, 73 NRC 19, 26 (2011).

[29] *Id.*

[30] *Id.*

[31] *Private Fuel Storage, LLC*, LBP-01-23, 54 NRC at 172 n.3.

timely filed.[32] In addition, an amended or new contention must also satisfy the general contention admissibility requirements of 10 C.F.R. § 2.309(f)(1), including providing: (i) "a specific statement of the issue of law or fact to be raised or controverted," (ii) "a brief explanation of the basis for the contention," (iii) a demonstration "that the issue raised in the contention is within the scope of the proceeding," (iv) a demonstration "that the issue raised in the contention is material to the findings the NRC must make,"[33] (v) "a concise statement of the alleged facts or expert opinions which support the [intervenor's] position on the issue," and (vi) "sufficient information to show that a genuine dispute exists with the applicant/licensee on a material issue of law or fact."

III. AMENDED OR MIGRATED CONTENTIONS

In its April 2, 2019 Scheduling Order, the Board ruled that new or amended contentions based on the DSEIS will be considered timely if filed on or before June 24, 2019.[34] Here, we timely update our two existing, admitted contentions to apply to the NRC Staff's DSEIS. While recognizing NRC regulations do not explicitly require Intervenors to migrate our already-admitted contentions by motion, we nevertheless refile these contentions now out of an abundance of caution, in order to preclude any subsequent assertion by the NRC Staff, the Applicant, or a reviewing tribunal that Intervenors have not pursued their rights as secured by the U.S. Constitution, the National Environmental Policy Act ("NEPA"), 42 U.S.C. § 4323 *et seq*., or regulations promulgated by the Council on Environmental Quality or the NRC. Thus, we

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[32] 10 C.F.R. § 2.309(f)(2) and 2.309(c)(1).

[33] A "material" issue is one that would make a difference in the outcome of the proceeding. Rules for Practice for Domestic Licensing Proceedings—Procedural Changes in the Hearing Process, 54 Fed. Reg. 33,168, 33,172 (Aug. 11, 1989). *Entergy Nuclear Vermont Yankee, LLC & Entergy Nuclear Operations, Inc.* (Vermont Yankee Nuclear Power Station), LBP-4-28, 60 NRC 548, 557 (Nov. 22, 2004).

[34] Scheduling Order at 3 (the revised scheduling order set the deadline for new or amended contentions based on the DSEIS at 45 days after initial disclosures due on May 10, 2019).

submit that all our objections that applied to the Applicant's Environmental Report now apply to the DSEIS. Further, boards have previously explained that "if there is any question about whether an admitted contention merits a new/amended contention motion relative to the Staff's environmental document, the best approach seemingly would be to make a filing that treats the contention as if it were new/amended or, perhaps most prudently, argues in the alternative."[35] Below, we therefore argue in the alternative to either migrate Contentions 1-E and 5-E or amend the contentions.

A. <u>Contention 1-E</u>

In its March 7, 2019 Order, the Board admitted Intervenors' Contention 1-E as a contention of omission as follows:

> In light of the adverse impact of continued cooling canal system operations on the threatened American crocodile and its critical seagrass habitat, the [Environmental Report] is deficient for failing to consider mechanical draft cooling towers as a reasonable alternative to the [cooling canal system] in connection with the license renewal of Turkey Point Units 3 and 4.[36]

Intervenors move to amend this Contention based on new and materially different information in the DSEIS. However, if the Board finds that the Contention is not admissible as amended, Intervenors alternatively move to migrate Contention 1-E as originally admitted.

***<u>AMENDMENDED CONTENTION 1-Eb</u>*: The DSEIS fails to analyze adequately mechanical draft cooling towers as a reasonable alternative that could mitigate adverse impacts of the cooling canal system in connection with the license renewal of Turkey Point Units 3 and 4.**

The Board should amend and admit Contention 1-E as Contention 1-Eb because good cause exists to amend the contention and Contention 1-Eb meets the admissibility requirements

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[35] *Strata Energy, Inc.* (Ross In Situ Recovery Uranium Project), LBP-13-10, 78 NRC 117 (July 26, 2013).

[36] Order at 44.

in 10 C.F.R. § 2.309(f).

First, good cause—defined as timely and based on previously unavailable and materially different information[37]—exists to amend Contention 1-E as Contention 1-Eb. Per the Board's Scheduling Order, this motion to amend is timely.[38] The DSEIS also includes new information that was previously unavailable in the Environmental Report; whereas the Environmental Report omitted cooling towers as an alternative to the cooling canal system, the DSEIS now includes a shallow, inadequate evaluation of cooling towers as a cooling water system alternative.[39] It is this inadequate evaluation that the amended Contention 1-Eb now challenges. Because the basic form of a contention cannot change through migration—i.e. "challeng[ing] the soundness of the information provided [rather than] claim[ing] that necessary information has been omitted"—Intervenors respectfully move to amend Contention 1-E from claiming an omission in the Environmental Report to challenging the adequacy of analysis newly included in the DSEIS.[40] Thus, there is good cause to amend Contention 1-E.

And, second, as we explain below, Contention 1-Eb meets the requirements in 10 C.F.R. § 2.309(f)(1) regarding contention admissibility. The Board should therefore admit Contention 1-Eb as amended.

1. Statement of the issue of law or fact to be raised or controverted (10 C.F.R. § 2.309(f)(1)(i))

The DSEIS fails to comply with 10 C.F.R. § 51.71(d) because it fails to include an adequate analysis of "alternatives available for reducing or avoiding adverse environmental

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[37] 10 C.F.R. § 2.309(f)(2) and 2.309(c)(1).

[38] Scheduling Order at 3.

[39] *See e.g.,* DSEIS at 2-12 – 2-13.

[40] *Private Fuel Storage, LLC*, LBP-01-23, 54 NRC at 172 n.3.

effects."[41] While the DSEIS considers a cooling water system alternative to the cooling canal system,[42] the DSEIS at best only analyzes the adverse impacts of constructing and operating the alternative;[43] the DSEIS unlawfully fails, however, to provide any analysis of the benefits to endangered species and the environment (described below) that would follow from replacing the cooling canal system with the cooling water system alternative. Intervenors have already shown in the Petition that cooling towers are a reasonable and feasible alternative to the cooling canal system,[44] and the NRC Staff seem to agree as they included cooling towers as the cooling water system alternative in the DSEIS.[45] However, the NRC Staff failed to complete an *adequate* alternatives analysis by failing to discuss how replacing the existing cooling canal system with cooling towers would reduce adverse impacts to Category 2 issues, as required by NRC regulations.

2. Brief explanation of basis for the contention (10 C.F.R. § 2.309(f)(1)(ii)); concise statement of the alleged facts or expert opinions supporting the contention (10 C.F.R. § 2.309(f)(1)(v)); and statement that a genuine dispute exists with the licensee on a material issue of law or fact (10 C.F.R. § 2.309(f)(1)(vi))

NEPA and NRC regulations require that a DSEIS "[r]igorously explore and objectively evaluate all reasonable alternatives."[46] An agency's consideration of reasonable alternatives is "the heart" of NEPA.[47] Specifically, NRC regulations require that a DSEIS include a mitigation

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[41] 10 C.F.R. § 51.71(d).

[42] DSEIS at 2-12 – 2-13.

[43] *See e.g.,* DSEIS at 4-11, 4-18 – 4-19, 4-41 – 4-42, 4-48, 4-59 – 4-60, and 4-70.

[44] Petition at 19-22.

[45] DSEIS at 2-12 – 2-13.

[46] 40 C.F.R. § 1502.14. The Council on Environmental Quality's regulations implementing NEPA apply to all federal agencies, including the NRC. *Union Neighbors United, Inc. v. Jewell*, 831 F.3d 564, 569 n.1 (D.C. Cir. 2016) (citing 40 C.F.R. § 1500.3).

[47] *Union Neighbors United,* 831 F.3d at 575 (citing 40 C.F.R. § 1502.14).

discussion analyzing "alternatives available for reducing or avoiding adverse environmental effects" of the proposed project.[48] This mitigation discussion must include an analysis of "*benefits* and costs of the proposed action *and alternatives*."[49] It is a vital part of the "action forcing" function of NEPA because "[w]ithout such a discussion, neither the agency nor other interested groups and individuals can properly evaluate the severity of the adverse effects."[50]

The DSEIS fails to satisfy the NEPA and NRC requirements to rigorously explore benefits and costs of a reasonable alternative available for reducing or avoiding adverse environmental effects of the relicensing. The DSEIS purports to satisfy NEPA's obligation to consider alternatives available for reducing adverse impacts of the cooling canal system by including the cooling water system alternative. Unlike for all the other alternatives examined, however, the DSEIS fails to analyze how the cooling water system alternative compares to the proposed action.[51] The DSEIS plays lip service to this requirement by claiming that it "evaluates an alternative cooling water system technology for Turkey Point Units 3 and 4 that might be used to mitigate the potential impacts associated with continued use of the existing cooling canal system."[52] But the DSEIS at best analyzes the *adverse* impacts of cooling towers; it is devoid of any substance on the environmental benefits of the alternative, for example the adverse impacts of the proposed action *that the alternative could reduce or avoid*, as required by 10 C.F.R. §

[48] 10 C.F.R. § 51.71(d).

[49] *Id.* (emphasis added).

[50] *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 352 (1989). *See also Hydro Res., Inc.* (P.O. Box 777, Crownpoint, New Mexico 87313), LBP-06-19, 64 NRC 53, 93 (Aug. 21, 2006) ("Mitigation must be discussed in sufficient detail to ensure that environmental consequences have been fairly evaluated").

[51] DESIS at 2-20 – 2-21 (In section 2.4 Comparison of Alternatives, the DESIS explains why the proposed action is preferable to the four other alternatives—no action, new nuclear, natural gas combined-cycle, and natural gas combined-cycle and solar photovoltaic combination—but makes no mention of the cooling water system alternative).

[52] DSEIS at 2-12.

51.71(d). Specifically, the DSEIS fails to consider how the cooling water system alternative could reduce acknowledged adverse impacts to (1) threatened, endangered, and protected species and essential fish habitat and (2) groundwater use conflicts.

a. Replacing the existing cooling canal system with cooling towers would reduce adverse impacts related to threatened, endangered, and protected species and essential fish habitat.

The DSEIS concludes that operating the cooling canal system another 20 years is "likely to adversely affect the American crocodile and eastern indigo snake," two special status species, and may affect other species.[53] Further, the DSEIS states that there would be SMALL to MODERATE impingement and entrainment impacts and thermal impacts on aquatic organisms.[54] The DSEIS acknowledges that the cooling canal system contributes to these adverse impacts.[55] Thus replacing the cooling canal system with cooling towers could reduce the adverse impacts to species and their habitat.

Both temperature and salinity in the cooling canals have increased. This has resulted in decreased nesting and fewer American crocodiles observed in the cooling canals.[56] In 2017, the FWS explained that:

> [T]here has been a reduction in the number of crocodile nests produced within the [cooling canal system]. A total of 9 nests were observed in 2015 and 8 in 2016. The decrease in nesting in the [cooling canal system] has occurred with a concomitant decrease in the number of crocodiles observed within the [cooling canal system]…. In addition, the body condition of many of the crocodiles

[53] DSEIS at xviii.

[54] *Id.*

[55] *See e.g.* DSEIS at 4-50, 4-54 ("The NRC staff acknowledges EAI's conclusion regarding seagrass and recognizes that thermal discharges associated with Turkey Point have contributed not only to the disappearance of seagrass within the [cooling canal system], but also to the decline of fish and other aquatic biota and the observed shift towards more heat-tolerant species in recent years."), 4-56; *see also* Biological Assessment for the Turkey Point Nuclear Generating Unit Nos. 3 and 4 Proposed Subsequent License Renewal, at 33 (Dec. 2018) (hereinafter "Biological Assessment") ("the NRC staff concludes that the current conditions within the [cooling canal system] are having an adverse impact on American crocodile nesting and hatchling success.").

[56] *See* Biological Assessment at 32.

> observed within the [cooling canal system] has decreased (i.e., animals appear emaciated and much thinner than healthy animals of the same total length). Moreover, anecdotal evidence suggests that a majority of the fish and invertebrate species that used to provide prey for the crocodile in the waters of the [cooling canal system] no longer occur or are greatly diminished in numbers… [These issues] are thought to be the result of the recent increase in water temperature and salinity, and decrease in water quality within the waters of [cooling canal system] observed during the past few years, beginning in 2013… [The cause for the decrease in water quality conditions] include [Applicant's] recent increase in power production from nuclear Units 3 and 4, [and] the discharge of vegetative cutting within the [cooling canal system].[57]

Increased temperature and salinity have also caused seagrass, that "once covered 50 percent of the system," to die off.[58] This has significantly changed the aquatic resources in the cooling canal system, such that "species diversity within the system has declined over time."[59] Furthermore, the cooling canal system has driven the westward migration of a hypersaline plume,[60] resulting in salination of freshwater wetlands that are habitat for a range threatened and endangered species, including the Florida panther, American crocodile, indigo snake, snail kite, red knot and wood stork.[61] Thus, ceasing operation of the cooling canal system as a heat sink and replacing them with cooling towers, while keeping the canals in place, could protect existing species habitat. With an adequate effort to freshen the canals, and without the dangerously high temperatures of the recent past, the canals would continue to provide valuable critical habitat into the future.[62]

The DSEIS fails, however, to adequately consider these benefits of the cooling tower

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[57] Biological Opinion for Combined License for Turkey Point Nuclear Plant, Units 6 and 7 (June 23, 2017), at 20 (ML17177A673) (hereinafter "2017 Biological Opinion").

[58] Biological Assessment at 19.

[59] *Id.* at 22.

[60] *See* Section IV.B.

[61] 2017 Biological Opinion, at 44.

[62] *See* Section IV.B.

alternative. In analyzing the alternative's impacts on aquatic resources, the DSEIS focuses on the adverse impacts of the alternative, for example stating that "[c]onstruction of cooling towers on the Turkey Point site would result in the permanent loss or impairment of sensitive aquatic habitats and could affect ecosystem function and connectivity."[63] The DSEIS analysis of the alternative in regards to species is even less adequate as it fails to even conduct the analysis. The DSEIS makes the excuse that "the magnitude and significance of adverse impacts on special status species and habitats would depend on the location and layout of the cooling towers, the design of the cooling towers, operational parameters, and the special status species and habitats present in the area when the alternative is implemented."[64] But these location and design parameters would not change the fact that Turkey Point Units 3 and 4 stopped utilizing the cooling canal system as a heat sink.

An analysis on the change to the cooling canal system should cooling towers be built should have been conducted to rigorously and objectively evaluate the alternative. But the DSEIS fails to complete this analysis and therefore fails to adequately analyze an alternative that could reduce or avoid adverse impacts of the project.

b. Replacing the existing cooling canal system with cooling towers would reduce adverse impacts related to groundwater use conflicts.

Turkey Point Units 3 and 4 currently rely on the cooling canal system as their cooling water system—the Units discharge heated water into the cooling canal system and, as the water travels through the cooling canal system, it loses heat through evaporation.[65] But, as the evaporation removes heat, it of course also removes water. Over the years, this water has been

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[63] DSEIS at 4-60.

[64] DSEIS at 4-70.

[65] DSEIS at 3-11.

replenished by (1) freshwater from precipitation, (2) saline water from the Biscayne aquifer, and occasionally (3) brackish water from the Florida aquifer.[66] However, as discharge from Units 3 and 4 has become hotter (increasing evaporation) and droughts have become more common (decreasing the freshwater precipitation replenishment), the salinity of the cooling canal system has increased. Units 3 and 4 are therefore a main contributing factor to the increased salinity of the cooling canal system.[67] And replacing the Unit's reliance on the cooling canal system with the alternative of cooling towers for their cooling water system would help reduce the salinity of the cooling canal system and the adverse impacts originating from that salinity.

The DSEIS acknowledges that the cooling canal system's increased salinity creates adverse impacts, including: die-off of sea grass, increased algae blooms, and the hypersaline plume.[68] But to redress the salinity levels in the cooling canal system—and reduce these adverse impacts—the DSEIS only analyzes adding more brackish water to the cooling canal system from the Florida aquifer and attempting to withdraw the hypersaline plume through wells.[69] Rather than reduce adverse impacts, these actions in fact only create new ones; evidence suggests the plan to withdraw the hypersaline plume will not be successful[70] and the DSEIS acknowledges that these actions will exacerbate groundwater use conflict by substantially increasing groundwater use and leading to drawdown of offsite production wells.[71]

Rather than focus on these subpar mitigation plans, the DSEIS should have completed the

[66] *Id.*

[67] *See* Section IV.B.

[68] *See* DSEIS at 3-43, 3-44, 3-54, 3-56, 3-99, 4-120.

[69] *See id.* at 3-80, 3-81, 4-116.

[70] *See* IV.B.

[71] *Id.* at 4-28–4-33, 4-115.

analysis it claims it would, by "evaluat[ing] an alternative cooling water system technology for Turkey Point Units 3 and 4 that might be used to mitigate the potential impacts associated with continued use of the existing cooling canal system."[72] By replacing the heat sink function of the cooling canals with cooling towers, an original substantial factor in the hypersalinity that created a host of adverse impacts could be addressed. The DSEIS should have completed this analysis so that "interested groups and individuals can properly evaluate the severity of the adverse effects."[73] But while the DSEIS analyzes groundwater demand for freshening the cooling canal system,[74] it does not analyze how ending the heat contribution of Turkey Point Units 3 and 4 to the cooling canals could freshen the water and reduce the groundwater impacts faster. The DSEIS only states that "the NRC staff expects that groundwater demands for [cooling canal system] freshening would decrease over time commensurate with the reduction in thermal discharge to the [cooling canal system] from Turkey Point Units 3 and 4, some use of groundwater (or other water sources) would likely continue into the future,"[75] but does not compare how significant this change would be. Thus, an analysis on the change to the cooling canal system and groundwater use conflict should cooling towers be built should have been conducted. But the DSEIS fails to complete this analysis and therefore fails to adequately analyze an alternative that could reduce or avoid adverse impacts of the project.

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[72] *Id.* at 2-12.

[73] *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 352 (1989). *See also Hydro Res., Inc.* (P.O. Box 777, Crownpoint, New Mexico 87313), LBP-06-19, 64 NRC 53, 93 (Aug. 21, 2006) ("Mitigation must be discussed in sufficient detail to ensure that environmental consequences have been fairly evaluated").

[74] *See* DSEIS at 4-42.

[75] *Id.*

3. The issue raised in the contention is within the scope of the proceeding (10 C.F.R. § 203.9(f)(1)(iii))

NRC regulations broadly divide the scope of a license renewal proceeding into (1) safety/aging management issues, and (2) environmental impacts. This contention concerns environmental impacts. The scope of the required environmental review is established by 10 C.F.R. Part 51 and the GEIS for license renewals.[76] This contention is within the scope of the proceeding because it challenges the sufficiency of the environmental analysis in the DSEIS.

4. The issue raised in the contention is material to the findings the NRC must make to support the action involved in the proceeding (10 C.F.R. § 2.309(f)(1)(iv))

An issue is "material" if "the resolution of the dispute would make a difference in the outcome of the licensing proceeding."[77] "This means that there must be some link between the claimed error or omission regarding the proposed licensing action and the NRC's role in protecting public health and safety or the environment."[78] The issue raised in this contention—the DSEIS's failure to comply with NRC's regulations requiring rigorous consideration of alternatives—relates directly to the NRC's role in protecting public health and safety and the environment. NEPA imposes requirements on the NRC to ensure environmental protection. The failure to comply with these requirements is material to the findings NRC must make to support relicensing.

***MIGRATED CONTENTION 1-E*: In light of the adverse impact of continued cooling canal system operations on the threatened American crocodile and its critical seagrass habitat, the DSEIS is deficient for failing to consider mechanical draft cooling towers as a reasonable alternative to the cooling canal system in connection with the license renewal of Turkey Point Units 3 and 4.**

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[76] *Entergy Nuclear Vermont Yankee, LLC* (Vermont Yankee), LBP-06-20, 64 NRC 131, 148-49 (2006).

[77] *Vermont Yankee*, LBP-06-20, 64 NRC at 149.

[78] *Id.*

In the alternative, if the Board finds that Contention 1-Eb is not admissible, Intervenors request that Contention 1-E migrate as presently admitted, with the term "Environmental Report" in the contention updated to the "DSEIS." Contention 1-E can migrate as admitted because the omission of information in the Environmental Report that the Contention challenges is sufficiently similar to the omission of information in the DSEIS. Thus, Contention 1-E now challenges that the NRC Staff's DSEIS fails to consider mechanical draft cooling towers as a reasonable alternative to the cooling canal system in light of the adverse impacts of continued operation of the cooling canal system on the threatened American crocodile and its critical seagrass.[79]

A contention migrates if the information it challenges in the Environmental Report is sufficiently similar to information included in the DSEIS. We must therefore first understand what information the contention aimed to challenge in the Environmental Report. As admitted, Contention 1-E on its face is specifically a claim that the Environmental Report omits analysis of cooling towers as an alternative *that could mitigate adverse impacts* of the cooling canal system specifically on the American crocodile and its critical seagrass habitat. In admitting the Contention, the Board's Order found that Contention 1-E "raises a genuine dispute on a material fact to the extent it alleges that [Applicant's Environmental Report] improperly fails to consider mechanical draft cooling towers as a reasonable alternative *for reducing or avoiding adverse impacts on the threatened American Crocodile and its critical seagrass habitat*."[80] By including the qualifying phrase regarding impacts to the American crocodile in the admitted Contention

[79] This issue has already been briefed by parties in their Motions to Dismiss as Moot. If the Board finds that the DSEIS does not moot Contention 1-E, the Contention should be allowed to migrate.

[80] *Turkey Point*, LBP-19-3, 89 NRC __ (slip op. at 40) (emphasis added). This statement appears in the Board's analysis of another Intervenor Southern Alliance for Clean Energy's ("SACE") Contention 2, but the Board admitted Joint Petitioners' Contention 1-E "subject to the same limitations" as its admission of SACE's Contention 2. *See* LBP-19-3, 89 NRC __ (slip op. at 44).

language, the Board focused the scope of the Contention on the omission of how the cooling towers could reduce adverse impacts of the cooling canal system specifically on this species and its habitat.

Like the Environmental Report, the DSEIS also fails to include a discussion of the reduction of adverse impacts to the American crocodile and its habitat that would be achieved by installing cooling towers. In the DSEIS "the NRC staff concludes that the proposed Turkey Point subsequent license renewal is likely to adversely affect the American crocodile … and may result in adverse modification to designated critical habitat for the American crocodile."[81] However, while the DSEIS claims it "evaluates an alternative cooling water system to mitigate the potential impacts associated with the continued use of the existing cooling canal system,"[82] the DSEIS actually only analyzes certain potential adverse impacts of the cooling towers. It omits any specific analysis of benefits of utilizing cooling towers as an alternative to the cooling canal system to mitigate the acknowledged adverse impact of the canal system on the American crocodile and its habitat.[83] Thus, the DSEIS is sufficiently similar to the Environmental Report in its failure to analyze the mechanical draft cooling towers as a reasonable alternative to the cooling canal system in light of the adverse impact of continued operation of the cooling canal system on the threatened American crocodile and its critical seagrass habitat; Contention 1-E should be allowed to migrate.

B. Contention 5-E

The Board admitted Contention 5-E as follows:

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[81] DSEIS at 4-23.

[82] DSEIS at iii.

[83] *See e.g.,* 2017 Biological Opinion at 68 (discussing select adverse impacts of cooling canal system on American crocodiles without discussing cooling towers as an alternative).

> The Environmental Report is deficient in its failure to recognize Turkey Point as a source of ammonia in freshwater wetlands surrounding the site, and in its failure to analyze the potential impacts of ammonia releases during the renewal period on threatened and endangered species and their critical habitat.[84]

Because the DSEIS is sufficiently similar to the Environmental Report in that both omitted any analysis of the potential impacts of ammonia on the threatened and endangered species identified by the Contention or on their critical habitat, Contention 5-E must be migrated with respect to the NRC Staff's DSEIS. In the alternative, if the Board finds that the DSEIS is not sufficiently similar to the Environmental Report on this issue, Intervenors move to amend Contention 5-E.

MIGRATED CONTENTION 5-E: **The DSEIS is deficient in its failure to analyze the potential impacts of ammonia releases during the renewal period on threatened and endangered species and their critical habitat.**

A contention migrates if the information it challenges in the Environmental Report is sufficiently similar to information included in the DSEIS. We must therefore first understand what information the contention aimed to challenge in the Environmental Report. To determine a contention's scope, the Board first analyzes the language of the contention, and, if the scope is not clear on the contention's face, the Board considers the statement of basis accompanying the contention.[85] The scope of Contention 5-E, as admitted and clarified in the basis statement, encompasses the impact of ammonia from continued operation of Turkey Point Units 3 and 4 on the following six threatened or endangered species and their habitat: the "Florida panther, American crocodile, indigo snake, snail kite, red knot and wood stork."[86]

The Environmental Report failed to consider the impact of ammonia discharges on these threatened and endangered species and important habitat. Similarly, the DSEIS also fails to

[84] Order at 52-53 (emphasis added).

[85] *Private Fuel Storage,* LBP-01-23, 54 NRC at 171.

[86] Petition at 60. *See also* Joint Petitioners' Answer Opposing FPL's Motion to Dismiss Joint Petitioners' Contention 5-E as Moot (June 10, 2019).

include this specific analysis. As the NRC's Biological Assessment for the subsequent relicensing of Turkey Point Units 3 & 4 notes, a specific evaluation of ammonia's impacts must consider "[s]everal water quality parameters, including pH, temperature, and salinity; the rate and duration of exposure; *and a species' specific physiobiology*. . . ."[87] While the DSEIS at least contemplates the impact of ammonia on one endangered species—the West Indian manatee—it fails to analyze this issue for the six species identified in Intervenors' contention.[88] Thus, the DSEIS is sufficiently similar to the Environmental Report in its failure to analyze the impact of ammonia discharges from Turkey Point Units 3 and 4 on the six named threatened or endangered species and their habitat. Contention 5-E should be allowed to migrate.[89]

***AMENDMENDED CONTENTION 5-Eb*: The DSEIS is deficient in its analysis of the potential impacts of ammonia releases during the renewal period on threatened and endangered species and their critical habitat.**

In the alternative, the Board should amend and admit Contention 5-E as Contention 5-Eb because good cause exists to amend the contention and Contention 5-Eb meets the admissibility requirements in 10 C.F.R. § 2.309(f).

First, good cause—defined as timely and based on new and materially different information[90]—exists to amend Contention 5-E as Contention 5-Eb. Per the Board's Scheduling Order, this motion to amend is timely.[91] The DSEIS also includes new information that was previously unavailable in the Environmental Report; whereas the Environmental Report did not

[87] Biological Assessment at 60.

[88] *See id* at 30-47, 51-55, 57-62.

[89] This issue has already been briefed by parties in their Motions to Dismiss as Moot. If the Board finds that the DSEIS does not moot Contention 5-E, the Contention should be allowed to migrate.

[90] 10 C.F.R. § 2.309(f)(2) and 2.309(c)(1).

[91] Scheduling Order at 3.

acknowledge that Turkey Point is a source of ammonia,[92] the DSEIS now admits to this fact but includes only a spotty, inadequate evaluation of how Turkey Point's continued operation as a source of ammonia will impact threatened and endangered species.[93] It is this inadequate evaluation that Contention 5-Eb now challenges. Because the basic form of a contention cannot change through migration—i.e. "challeng[ing] the soundness of the information provided [rather than] claim[ing] that necessary information has been omitted"—Intervenors respectfully move to amend Contention 5-E from claiming an omission in the Environmental Report to challenging the adequacy of analysis in the DSEIS.[94] Thus, there is good cause to amend Contention 5-E.

And, second, as we explain below, Contention 5-Eb meets the requirements in 10 C.F.R. § 2.309(f)(1) regarding contention admissibility. The Board should therefore admit Contention 5-Eb as amended.

1. Statement of the issue of law or fact to be raised or controverted (10 C.F.R. § 2.309(f)(1)(i))

NRC regulations require the DSEIS to consider the effects of Turkey Point's continued operation on endangered species.[95] The DSEIS acknowledges that Turkey Point is a source of ammonia,[96] but it gives inadequate consideration to how the ammonia released will impact threatened or endangered species, or otherwise harm important plant and animal habitats, over the next 20 years. This failure violates NEPA.

2. Brief explanation of basis for the contention (10 C.F.R. § 2.309(f)(1)(ii)); concise statement of the alleged facts or expert opinions supporting the contention (10

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[92] ER at 9-13, 3-93 – 3-94.

[93] DSEIS at 3-52, 2-12 – 2-13.

[94] *Private Fuel Storage, LLC*, LBP-01-23, 54 NRC at 172 n.3.

[95] 10 C.F.R. § 51.71 (requiring a DSEIS analyze Category 2 issues); s*ee also,* 10 C.F.R. Part 51, Subpart A, Appendix B (listing "threatened, endangered, and protected species and essential fish habitat" as a Category 2 issue).

[96] DSEIS at 3-52.

C.F.R. § 2.309(f)(1)(v)); and statement that a genuine dispute exists with the licensee on a material issue of law or fact (10 C.F.R. § 2.309(f)(1)(vi))

Turkey Point discharges ammonia from the cooling canal system to nearby surface waters via the Biscayne Aquifer. Specifically, violations of surface water ammonia standards have been observed in canals near Turkey Point.[97] The DSEIS acknowledges that Miami-Dade County has offered evidence that Turkey Point is a key source of the ammonia and is responsible for the violations of water quality standards.[98]

Ammonia can have direct and highly toxic effects on the aquatic environment.[99] While the DSEIS speaks generally to the effects of elevated ammonia on water quality[100] and "aquatic organisms," it does not mention any threatened or endangered species in this discussion.[101] Individualized analysis by species is vital because, as the NRC's Biological Assessment for the subsequent relicensing of Turkey Point Units 3 & 4 notes, a specific evaluation of ammonia's impacts must consider "[s]everal water quality parameters, including pH, temperature, and salinity; the rate and duration of exposure; and a *species' specific physiobiology*. . . ."[102]

Yet the DSEIS fails to consider the impacts of ammonia discharges on all but one threatened and endangered species and important habitat.[103] For example, in the Biological Assessment's Section 5.1.2 on "Impacts to the American Crocodile and Designated Critical

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[97] Letter from Wilbur Mayorga (Miami-Dade County, Division of Environmental Resources Management) to Matthew J. Raffenberg (Applicant) at 1-2 (July 10, 2018) ("Mayorga – Raffenberg Letter").

[98] DSEIS at 3-52 (citing Mayorga – Raffenberg Letter).

[99] DSEIS at 4-65; Final Aquatic Life Ambient Water Quality Criteria for Ammonia – Freshwater 2013, 78 Fed. Reg. 52,192 (Aug. 22, 2013).

[100] DSEIS at 3-42 – 3-44.

[101] DSEIS at 4-65.

[102] Biological Assessment at 60 (Dec. 2018) (emphasis added).

[103] *See* Biological Assessment.

Habitat," the word ammonia does not even appear.[104] One need only compare the NRC's analysis of ammonia impacts on another species—the West Indian manatee—to grasp the inadequacy of the remainder of DSEIS's analysis.[105] There, the NRC attempted to connect the dots by specifically addressing the impacts of ammonia—not "nutrients" generally—on the manatee.[106] Further, the DSEIS provides no explanation why this level of analysis was included for the manatee and not any other species. Thus, the DSEIS's analysis of how ammonia may impact threatened and endangered species is inadequate.

3. The issue raised in the contention is within the scope of the proceeding (10 C.F.R. § 203.9(f)(1)(iii))

NRC regulations plainly require the DSEIS to address the effects of Turkey Point's continued operations on endangered species.[107] The effects on these resources in Turkey Point's cooling canal system are therefore within the scope of this proceeding.

4. The issue raised in the contention is material to the findings the NRC must make to support the action involved in the proceeding (10 C.F.R. § 2.309(f)(1)(iv))

A contention is "material" to the NRC's duty to make environmental findings if the issue of law or fact it raises "is of possible significance to the result of the proceeding. This means that there should be some significant link between the claimed deficiency and either the health and safety of the public or the environment."[108] There is a significant link between the issue raised in

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[104] *Id.* at 30-45.

[105] *Compare* Biological Assessment at 60–62 (analyzing ammonia impacts on the West India manatee) *to* Biological Assessment at 45-47, 51–55, 57–62 (failing to analyze ammonia impacts to any other threatened or endangered species).

[106] *See* Biological Assessment at 60–62.

[107] 10 C.F.R. § 51.71 (requiring a DSEIS analyze Category 2 issues); s*ee also,* 10 C.F.R. Part 51, Subpart A, Appendix B (listing "threatened, endangered, and protected species and essential fish habitat" as a Category 2 issue).

[108] *Entergy Nuclear Vt. Yankee L.L.C. & Entergy Nuclear Operations* (Vermont Yankee Nuclear Power Station), LBP-04-28, 60 NRC 548, 556–57 (Nov. 22, 2004).

this contention—Applicant's failure to assess the impacts of Turkey Point's operations on threatened and endangered species—and "the health and safety of the public or the environment."[109] NRC regulations require the DSEIS to include such an analysis. Each aspect of the contention relates directly to an impact on the environment and, thus, is material to the findings the NRC must make to support relicensing.

IV. NEW CONTENTIONS

A. Overview

Intervenors offer the following new contentions. Each new contention is based on information that did not appear in the Environmental Report, was unavailable at the time Intervenors filed their initial petition to intervene, is raised in timely fashion pursuant to the Board's Scheduling Order, is materially different, and establishes a genuine dispute on a material issue of law or fact that is within the scope of this proceeding.[110]

These contentions address what is generally categorized as a Category 1 issue (groundwater quality degradation (plants with cooling ponds in salt marshes)) as well as an issue that is neither Category 1 or Category 2 (water quality impacts on adjacent water bodies (plants with cooling ponds in salt marshes)). While Intervenors believe a waiver under 10 C.F.R. § 2.335(b) is not necessary in order for Intervenors to assert contentions addressing these issues, we also submit a waiver out of an abundance of caution.[111]

B. New Information

[109] *Id.*

[110] 10 C.F.R. §§ 2.309(f)(1), 2.309(c)(1).

[111] NRDC's, FOE's, and Miami Waterkeeper's Petition for Waiver of 10 C.F.R. §§ 51.53(C)(3) and 51.71(D) and 10 C.F.R. Part 51, Subpart A, Appendix B (June 24, 2019).

Intervenors rely on the following new information in support of their new contentions.

1. Miami-Dade County Petition for Administrative Hearing ("MDC Petition").[112] On September 17, 2018, Miami-Dade County filed a petition challenging Everglades Mitigation Bank Phase II Permit Modification No. 0193232-182 (the "Permit Modification"). The Permit Modification requires Applicant to: (i) change the "elevation of water control structures to a lower, fixed elevation, which will drain more water from the L-31E canal" and (ii) allow the transfer of *more* than 7,000 acre-feet of water per year through the L-31E levee to Applicant's mitigation lands south of the plant.[113]

As the following excerpts from the MDC Petition demonstrate, and as confirmed by the Dr. William Nuttle, Applicant's compliance with the Permit Modification substantially changes the region's hydrological profile.

- The 2015 Consent Agreement between Applicant and Miami-Dade requires Applicant to "rais[e] the control elevations of the FPL Everglades Mitigation Bank culvert weirs to no lower than 0.2 feet below the 2.4 foot trigger of the S-20 structure and maintain[] this elevation."[114]
- These "culvert weirs" are water control structures that determine how much freshwater is diverted from the L-31E canal to Applicant's southern mitigation bank lands.[115]
- "One goal of the weir elevation requirements in the County's Consent Agreement was to maintain more water on the surface landscape in the wetland areas to the west of the Cooling Canal System; that additional water creates a hydrologic 'head' that acts as a counterbalance to prevent additional saltwater intrusion in the groundwater area. These areas to the west of the Cooling Canal System are the same areas where FPL's hypersaline

[112] Miami-Dade County. Miami-Dade County Petition for Administrative Hearing. (Sept. 17, 2018) (hereinafter "MDC Petition").

[113] MDC Petition at 1.

[114] MDC Petition ¶ 13.

[115] MDC Petition ¶ 14.

groundwater plume has been detected."[116]

The MDC Petition further indicates that Applicant's compliance with the new control elevation requirements will lead to materially significant environmental impacts:

- The Permit Modification's new "control elevation requirement may exacerbate the existing water quality violations that FPL is otherwise working to abate and remediate, thus hindering the progress of those efforts and harming wetlands in the Model Lands area."[117]
- "[S]etting the control elevation of the L-31E water control structures [at the new, lower level] is not sustainable from a broader water management perspective."[118]

2. New Reports – Newly available data indicates that the 2015 Consent Agreement between Applicant and Miami-Dade County ("MDC Consent Agreement")[119] and the 2016 Consent Order between Applicant and FDEP[120] are not achieving the anticipated results regarding mitigation of the hypersaline plume and salinity management in the cooling canal system.[121] This data includes information found in the following:

- Turkey Point Cooling Canal System Baseline CSEM Report (Oct. 2018).
- FPL, 2018 Annual Turkey Point Power Plant Remediation/Restoration Report (Dec. 2018).
- FPL Recovery Well System Startup Report (Oct. 5, 2018).

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[116] MDC Petition ¶ 15.

[117] MDC Petition ¶ 23.

[118] MDC Petition ¶ 24.

[119] Miami-Dade County, "Consent Agreement Concerning Water Quality Impacts Associated with the Cooling Canal System at Turkey Point Power Plant" (Oct. 6, 2015) (ML16335A219) (referenced in DSEIS as MDC 2015a).

[120] FDEP, "Consent Order, OGC File 13 Number 16-0241, between the State of Florida Department of Environmental Protection and 14 Florida Power & Light Company regarding settlement of Matters at Issue [Westward Migration of 15 Hypersaline Water from the Turkey Point Facility and Potential Releases to Deep Channels on 16 the Eastern and Southern Side of the Facility]" (June 20, 2016) (ML16216A12) (referenced in DSEIS as FDEP 2016e).

[121] *See* DSEIS at 3-49 (suggesting that "more favorable climatic conditions . . . should help to reduce [cooling canal system] water salinities to 34 PSU").

3. Expert Report and Opinions of Dr. William Nuttle, Ph.D, which state:

- New information provided by Miami-Dade County points to material and significant changes to the hydrology of the Turkey Point region as the result of water management decisions since Florida Power & Light (FPL) submitted its Environmental Report.[122]

- Applicant's compliance with this modified permit exacerbates impacts from operating the cooling canal system on groundwater, surface water, and ecological resources in the Model Lands Basin.[123]

- New information on mechanisms of drought in south Florida provides evidence that "more favorable climatic conditions" that are being relied on to meet salinity targets in the CCS are unlikely to occur.[124]

- The ongoing dispute between the County and FDEP over setting the elevation of the weirs along the L-31E canal is evidence that achieving compliance with requirements for remediation established by DERM and FDEP does not reliably predict future compliance with state and local water quality requirements.[125]

4. Expert Report and Opinions of E.J. Wexler, P.Eng, which states:

- Tetra Tech modeling from 2016 has serious flaws that are especially critical in light of new water quality information showing that Applicant was unable to achieve freshening of the cooling canal system with the addition of 10 to 15 MGD of brackish water from the Floridan aquifer.[126]

- Mr. Wexler's modeling demonstrates that retraction of the hypersaline plume is not likely to occur without the addition of more wells and increased pumped volumes.[127]

- Modeling indicates that freshening of the cooling canal system is the key driver to retraction of the hypersaline plume; not pumping.[128]

- Applicant's models (Tetra Tech 2016a, 2016b, and 2017) indicate that

[122] Nuttle Decl. at 2.

[123] *Id*. at 4.

[124] *Id*. at 8.

[125] *Id*. at 10.

[126] Wexler Decl. at 4.

[127] *Id*. at 5.

[128] *Id*. at 4.

meeting the 2016 order with FDEP is not achievable with the number of wells and pumping volumes proposed.[129]

- More analysis would be required to determine whether additional withdrawals would have harmful environmental effects.[130]

5. Expert opinion of Dr. James Fourqurean, Ph.D., which states:

- The seagrass beds of Biscayne Bay and the rest of south Florida require very low nutrient loading to survive. In essence, seagrasses are killed and replaced by fast-growing, noxious seaweed or planktonic algae if nutrient delivery is increased. Nutrient delivery can be increased either by increasing the concentration of nutrients in discharges, OR by increasing the volume of water containing nutrients, even at very low nutrient concentrations that would pass drinking water quality standards.[131]

- The seagrasses along the coastline of the Cooling Canal System (CCS) existed for thousands of years in a nutrient-limited state, which means any addition of new nutrients changes the balance of these ecosystems. Increased nutrients harm the ecosystem by increasing the rates of primary production by marine plants. Increase in growth rates means that faster-growing, noxious marine plants, like macroalgae (seaweeds) and microscopic algae and photosynthetic bacteria, overgrow and outcompete seagrasses and corals for light, leading to the losses of corals and seagrasses.[132]

- Around the world, there are many nutrients that can limit noxious plant growth, but most often, the nutrients that limit this growth are either nitrogen or phosphorus. In south Biscayne Bay, phosphorus is limiting to phytoplankton and macroalgae. This means that addition of phosphorus will upset the ecological balance of seagrass beds as has been exhibited in Northern Biscayne By and Florida Bay. Upsetting the balance of populations of aquatic flora and fauna by nutrient addition is a violation of Florida surface water quality standards.[133]

- Current seagrass species composition and abundance data collected by ongoing seagrass monitoring programs show that there are places where Turtle Grass biomass offshore from the CCS is unusually dense compared to other areas in southern Biscayne Bay, likely as a consequence of increased P

[129] *Id*. at 5.

[130] *Id*.

[131] Fourqurean Decl. at 2.

[132] *Id*. at 4.

[133] *Id*.

availability in the region and concentrated by the operations of the adjacent CCS. The P sources are likely to be the result of Turkey Point operations that includes chemical components added for cleaning, biomass death that occurred within the CCS in 2014, and any nutrient pulled into the system from the surrounding environment that has been concentrated overtime as the freshwater evaporates away over the life of the plant.[134]

- The nearshore seagrass beds are incredibly efficient at removing P from the water column and storing P at vanishingly small concentrations. In fact, even 30 feet from large point-sources of P in Florida Bay, it is not possible to measure increases in P concentrations in the water column because it has all been captured by the algal and seagrass communities. This P capture causes increased plant growth and ecosystem imbalances. This imbalance first leads to an actual increase in the abundance of seagrass, but rapidly it causes a change in species composition, first to faster-growing seagrasses, then to seaweeds, then to microscopic algae.[135]

- Groundwater discharges along the coast of southern Biscayne Bay contain elevated concentrations of phosphorus and tritium, so that any process that causes groundwater discharge to the local seagrasses will supply the limiting nutrient (P) that upsets the balance of the ecosystem. Groundwater under the seagrass meadows of this part of Biscayne Bay contain tritium at concentrations that can only be explained by this water coming from the CCS.[136]

- The geology underlying the CCS and the adjacent seagrass meadows is based on limestone, which is made of calcium carbonate minerals. Calcium carbonate minerals strongly absorb orthophosphate onto their surfaces. But, respiration by plants, animals and bacteria dissolve calcium carbonate minerals, releasing the orthophosphate absorbed to the surfaces. During normal conditions, south Florida ecosystems are incredibly efficient at holding on to captured phosphorus– so much so that the impacts caused by adding P to seagrass beds in south Florida for even short periods can still be measured 30 years after the P additions. On the other hand, bacteria cause added N captured by south Florida ecosystems to be rapidly removed from those ecosystems. These facts result in P additions causing permanent and cumulative imbalances in nearshore marine waters of the Keys while N additions cause imbalances that can be corrected by the cessation of N addition.[137]

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[134] *Id*. at 5.

[135] *Id*. at 6.

[136] *Id*.

[137] *Id*. at 7.

- An imbalance of the seagrasses that form the near-shore habitat near the CCS in Biscayne Bay and provide the food at the base of the food chain harms the fish and wildlife that use these habitats and therefore effects fishing, recreational activities such as bird watching and other activities based on that habitat change and eventual loss.[138]

C. The Information Intervenors' Rely On Satisfy the "Good Cause" Standard in 10 C.F.R. § 2.309(c)(1).

New contentions are properly admissible upon a showing of good cause that (1) "[t]he information upon which the filing is based was not previously available," (2) "[t]he information upon which the filing is based is materially different from information previously available," and (3) "[t]he filing has been submitted in a timely fashion based on the availability of the subsequent information."[139] Each of the new sources of information Intervenor relies on for its new contentions meets these requirements. Good cause therefore exists for admitting each new contention.

1. The MDC Petition.

a. Not Previously Available. 10 C.F.R. § 2.309(c)(1)(i).

Intervenors base their new contentions in part on the Miami-Dade Petition, which is dated September 17, 2018. Intervenors filed their Petition to Intervene on August 1, 2018[140] and their Reply Brief on September 10, 2018.[141] Thus, the MDC Petition was not available at the time of Intervenors' Petition or Reply Brief.

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[138] *Id.* at 8.

[139] 10 C.F.R. § 2.309(c)(1). New and amended contentions must also meet the 6-part test governing admissibility in 10 C.F.R. § 2.309(f)(1).

[140] Petition at 1.

[141] Reply in Support of Request for Hearing and Petition to Intervene Submitted by Friends of the Earth, Natural Resources Defense Council, and Miami Waterkeeper (Sept. 10, 2018) (ML18253A280).

b. Materially different information from what was previously available. 10 C.F.R. § 2.309(c)(1)(ii).

Information is "materially different" "[u]nless it looks genuinely plausible that inclusion of an additional factor or use of other assumptions and models may change the cost-benefit conclusions."[142] Materiality in this context "relates to the magnitude of the difference between the previously available information and currently available information."[143]

The MDC Petition satisfies the "materially different" requirement because it provides information showing that it "looks genuinely plausible" that Applicant will not be able to comply with the MDC Consent Agreement. The DSEIS relies heavily on Applicant's ability to comply with this Agreement in its analysis of environmental impacts from the continued operation of Turkey Point Units 3 and 4.[144] This includes the DSEIS conclusion with respect to impacts on adjacent surface water bodies via the groundwater pathway.[145]

In the MDC Petition, Miami-Dade challenges a new requirement imposed on Applicant by the FDEP through a modified permit. The modified permit requires Applicant to take steps that that would materially change the region's hydrology, exacerbate Applicant's water quality

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[142] *See DTE Electric Co.* (Fermi Nuclear Power Plant, Unit 2), LBP-17-1, 85 NRC at 4 (Jan. 10, 2017).

[143] *S. Nuclear Operating Co.* (Vogtle Elec. Generating Plant, Units 3 & 4), LBP-10-01, 71 N.R.C. 165, 183 n.9 (2010).

[144] *See, e.g.*, DSEIS at 4-23 ("[U]pon consideration of the FDEP's and DERM's existing requirements and their continuing oversight of FPL's site remediation efforts, the NRC staff concludes that the impacts on adjacent surface water bodies via the groundwater pathway from the [cooling canal system] during the subsequent license renewal term would be SMALL and, therefore, the new information that has been identified is not significant.");

DSEIS at 4-27 ("[T]he NRC staff concludes that as a result of FPL's operation of its recovery well system and continued regulatory oversight and enforcement of the terms of the consent order and consent agreement by the FDEP and DERM, the impacts on groundwater quality from operations during the subsequent license renewal term would be SMALL.");

DSEIS at 4-117 ("The NRC Staff expects that continued operation of the freshening system, combined with proper operation and maintenance of the [cooling canal system], will result in no substantial contribution to cumulative impacts on groundwater quality or associated impacts on surface water quality in Biscayne Bay during the subsequent license renewal period.").

[145] DSEIS at 4-23.

violations, and interfere with Applicant's remedial efforts under the MDC Consent Agreement. As noted in the MDC Petition, FDEP modified Applicant's Mitigation Bank Phase II permit by lowering control elevations of the L-31E water control structure to an unchanging level of 1.8 feet NGVD.[146] The MDC Petition asserts that this new "control elevation requirement may adversely impact water resources upstream of the area, is not sustainable over the long term, and interferes with protecting water quality in the L-31E canal from chloride contamination and addressing the existing inland migration of the salt intrusion front in this area."[147] It "may exacerbate the existing water quality violations that [Applicant] is otherwise working to abate and remediate, thus hindering the progress of those efforts and harming wetlands in the Model Lands area."[148] Further, "setting the control elevation of the L-31E water control structures at an unchanging level of 1.8 feet NGVD is not sustainable from a broader water management perspective."[149]

The MDC Petition establishes facts that are materially different than the information previously available in several ways. First, the MDC Petition is relevant to issues and related conclusions that appear for the first time in the DSEIS.[150] These conclusions rely heavily on oversight and compliance with requirements predicated on a different hydrologic regime. Miami-Dade is now on record stating those predicate conditions have materially changed.

[146] MDC Petition ¶ 23.

[147] MDC Petition ¶ 23.

[148] MDC Petition ¶ 23.

[149] MDC Petition ¶ 24.

[150] *See., e.g.*, DSEIS at 4-2 ("The NRC staff . . . identified one new issue (i.e., water quality impacts on adjacent water bodies (plants with cooling ponds in salt marshes))"); DSEIS at 4-21 ("Specifically, the GEIS (NUREG-1437) did not consider how a nuclear power plant with a cooling pond in a salt marsh may indirectly impact the water quality of adjacent surface water bodies via a groundwater pathway. This constitutes a new, site-specific issue with respect to Turkey Point . . . .").

Second, the MDC Petition is "materially different" than previous information because it demonstrates FDEP's and Miami-Dade's "existing requirements" are incompatible.[151] Miami-Dade states that FDEP's permit modification "may exacerbate the existing water quality violations that [Applicant] is otherwise working to abate and remediate, thus hindering the progress of those efforts and harming wetlands . . . ."[152] Finally, the very fact that two agencies with oversight over water resources disagree is material to this proceeding. Logically, the NRC cannot conclude that compliance with and oversight by FDEP *and* Miami-Dade's requirements will result in SMALL environmental impacts when Miami-Dade is on record stating FDEP's requirements are incompatible with its own. Nor can the NRC rely on the mere existence of a permit requirement as a substitute for NEPA review.[153]

Intervenors also offer the expert opinions of Dr. William Nuttle to further explain why the concerns listed in the MDC Petition are justified and material to this proceeding. Dr. Nuttle explains that lowering weirs in the L-31E canal will drain freshwater from the Model Lands Basin, which sits west of the L-31E canal. This has the effect of lowering the water table throughout the Model Lands Basin, which reduces the natural hydraulic barrier against the encroachment of saltwater into the Biscayne aquifer, and it increases the vulnerability of water supply wells adjacent to the Model Lands Basin to degradation by saltwater intrusion, including the risk of degradation by the hypersaline plume emanating from the cooling canal system.

[151] *See, e.g.*, DSEIS at 4-23 (relying on "FDEP's and DERM's existing requirements and their continuing oversight of FPL's site remediation efforts" to conclude impacts via the groundwater pathway would be SMALL); DSEIS at 4117 ("The NRC staff finds that it is reasonable to expect that FPL's freshening well system would continue to be operated during the subsequent license renewal term, and for as long as necessary to maintain compliance with the terms of the 2015 consent agreement with Miami-Dade Count DERM [] and the 2016 FDEP consent order [].").

[152] MDC Petition ¶ 23.

[153] *Sierra Club v. Fed. Energy Regulatory Comm'n*, 867 F.3d 1357, 1375 (D.C. Cir. 2017) (citing *Calvert Cliffs' Coordinating Comm. V. Atomic Energy Comm'n*, 449 F.2d 1109, 1122–23 (D.C. Cir. 1971).

Lowering the water table in the Model Lands Basin also increases the flow of saline water into the L-31E canal and movement throughout the basin, which further degrades the freshwater wetlands.

These hydrological conditions are materially different than those presented in the Environmental Report according both to Dr. Nuttle and Miami-Dade. The record in this proceeding is devoid of any evidence that addresses environmental impacts complained of by Miami-Dade.

c. Timely. 10 C.F.R. § 2.309(c)(iii).

Section 2.309(c)(iii) does not define the term "timely." Thus, the Board has "a degree of latitude" in determining compliance with this standard.[154] The Board may, as it has done here, "define timeliness by specifying a deadline for timely filing a new or amended contention following a 'triggering event' that makes the previously unavailable/materially different information available so as to be the basis for the new or amended contention."[155] Further, the Board has previously ruled that while "intervenors must respond to new information when it first becomes available, they need not do so until the information is actually used by the NRC Staff to form its conclusions on impacts in the DSEIS."[156]

The Board's Scheduling Order established a June 24, 2019 deadline for filing of new and amended contentions. Intervenors' new contentions are filed in accordance with that deadline and are therefore timely. Additionally, to Intervenors' knowledge, there was no record of the MDC Petition in this proceeding until after the Board's April 2, 2019 Scheduling Order. On

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[154] *Crow Butte Res., Inc.* (Marsland Expansion Order) LBP-18-3 at 8 (July 20, 2018).

[155] *Id.*

[156] *Powertech USA, Inc*. (Dewey-Burdock In Situ Uranium Recovery Facility), LBP-13-09, 78 NRC 37, 93 (2013).

April 3, 2019, Applicant submitted "more recent additional information to support the Staff's review of [Applicant's Subsequent License Renewal Application] for Turkey Point Units 3 and 4."[157] The 2018 Annual Report appears to be the first time the MDC Petition is mentioned by Applicant in connection or referenced in any of the NRC Staff's NEPA-related documents in this proceeding.[158] In turn, the NRC Staff listed the 2018 Annual Report in its initial disclosures dated May 10, 2019.[159] Thus, any contention based on the MDC Petition is timely.

2. New Reports.

a. Not previously available. 10 C.F.R. § 2.309(c)(1)(i).

The new reports referenced in paragraph 2, Section IV(B), above, were not available when Intervenors filed their petition on August 1, 2018. Applicant released the "Turkey Point Cooling Canal System Baseline CSEM Report" and "Recovery Well System Startup Report in October 2018; and the "2018 Annual Turkey Point Power Plant Remediation/Restoration Report" in December 2018. Thus, this information was not previously available.

b. Materially different information from what was previously available. 10 C.F.R. § 2.309(c)(1)(ii).

These reports are materially different than information previously available in the Environmental Report. The Environmental Report did not state that Applicant's efforts to reach 34 PSU in the cooling canals system were ineffective. In contrast, the DSEIS explains that Applicant's modelers predicted freshening efforts "would require less than a year to reduce

[157] *See* Letter from William Maher, Senior Licensing Direct, Florida Power & Light Co., to NRC, Enclosure 3 (ML19095B380).

[158] *See* 2018 Annual Report at 18 (referencing MDC DERM's challenge to the FDEP Permit modification) (ML191095B494).

[159] NRC Staff Initial Disclosures, Hearing File Index at 19, Doc. ID# NRC-0280 (May 10, 2019) (ML19130A049). While the NRC Staff index dates this record December 31, 2018, Applicant submitted it to the NRC on April 3, 2019 to provide "more recent additional information for the SLRA Environmental Report."

salinities in the [cooling canal system] to 35 PSU."[160] Yet average salinity concentrations in the cooling canal system only reached 64.9 PSU.[161] The DSEIS also explained for the first time that these "modelers anticipate that under more favorable climatic conditions (e.g., less severe dry seasons), the addition of Upper Floridan aquifer water should help to reduce [cooling canal system]."[162] The previous statement indicates that the modeling efforts were not sufficient and that further inquiry is necessary to determine what climatic conditions are needed to meet the salinity target and whether those conditions are likely to occur. These inquiries are absent in the DSEIS. Without any evidence that Applicant will be able to meet its salinity targets, the only thing left supporting the DSEIS conclusions is the mere existence of a requirements and agencies to oversee them. This is not enough to satisfy NEPA, particularly when, as noted above in Section IV.C.1., those agencies are at loggerheads.[163]

c. Timely Submitted. 10 C.F.R. § 2.309(c)(iii).

Intervenors today submit new contentions based on the new reports pursuant to the April 2, 2019 Scheduling Order. It is timely for this reason alone. However, additionally, Applicant did not submit the "2018 Annual Turkey Point Power Plant Remediation/Restoration Report" or the "Recovery Well System Startup Report" to the NRC Staff until April 3, 2019 as part of a package of "more recent additional information to support the Staff's review of [Applicant's Subsequent License Renewal Application]."[164] This is after the Board issued the April 2, 2019 Scheduling Order and also after the NRC Staff released the DSEIS for public comment in March

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[160] DSEIS at 3-49.

[161] *Id.*

[162] DSEIS at 3-49.

[163] *Sierra Club v. Fed. Energy Regulatory Comm'n*, 867 F.3d 1357, 1375 (D.C. Cir. 2017) (citing *Calvert Cliffs' Coordinating Comm. V. Atomic Energy Comm'n*, 449 F.2d 1109, 1122–23 (D.C. Cir. 1971).

[164] ML19095B380.

2019.

Lastly, contentions based on the new reports are timely because the DSEIS is the first environmental document in this proceeding that relies on an unsubstantiated statement by Applicant's modelers that more favorable climatic conditions will achieve salinity targets in the cooling canal system. Before that, Intervenors could not have addressed the basis for the Staff's conclusion because the Staff had not made it.[165]

3. New Expert Opinions.

a. Not previously available. 10 C.F.R. § 2.309(c)(1)(i).

The new expert opinions that Intervenors supply herein were not previously available. They rely in part on the new information described in paragraphs 1 and 2 in Section IV.B., above. To the extent that an expert opinion addresses information that predates Intervenors' August 1, 2018 Petition, that information was no previously "available" because Applicant failed to reference the information to support its conclusions.[166] In addition, the DSEIS references Applicant's 2017 Annual Monitoring Report to explain that Applicant's efforts to reduce salinities in the cooling canal system were substantially worse than Applicant predicted while the Environmental Report did not.[167]

b. Materially different information from what was previously available. 10 C.F.R. § 2.309(c)(1)(ii).

The expert opinions are materially different than what was previously available because they rely on new information and provide evidence that creates a genuine dispute of fact and law

[165] *See Powertech USA, Inc.* (Dewey-Burdock In Situ Uranium Recovery Facility), LBP-13-09, 78 NRC 37, 93 (2013) (while "intervenors must respond to new information when it first becomes available, they need not do so until the information is actually used by the NRC Staff to form its conclusions on impacts in the DSEIS.").

[166] These include FPL 2017b and Tetra Tech 2016.

[167] DSEIS at 3-49.

regarding several conclusions in the DSEIS. At the most basic level, unlike conclusions in the Environmental Report and DSEIS, the expert opinions of Dr. Nuttle and Mr. Wexler provide evidence that ongoing efforts to remediate the hypersaline plume and reduce salinity levels in the cooling canals are not working, will not work, and therefore cannot be relied on to conclude that environmental impacts associated with the cooling canal system will be SMALL or insignificant during the subsequent license renewal period.

Dr. Fourqurean's report, which updates an earlier submission in this proceeding, describes ongoing impacts to seagrass communities adjacent to the cooling canal system. Since his previous submission, he has analyzed seagrass samples for indications of excess phosphorous loadings in surface waters adjacent to the cooling canal system. He only recently presented these results of his seagrass in April 2019. The results show measurable impacts on seagrass that are likely caused by operation of the cooling canal system. The data indicate signs of abnormally high phosphorus levels in areas that hydrological models indicate are impacted by discharges from the cooling canal system via the groundwater pathway. The continued loading of phosphorus leads to an imbalance of nutrients and the eventual death of seagrass, which is a foundation species in essential fish habitat for Biscayne Bay. These new findings contradict conclusions in the DSEIS that impacts on adjacent water bodies have been slight.[168]

Thus, these opinions, jointly or severally, are materially different than information that was previously available. Each opinion presents information that was not previously available and addresses information in the DSEIS that is materially different from what Applicant presented in the Environmental Report.

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[168] DSEIS at 4-23.

c. Timely Submitted. 10 C.F.R. § 2.309(c)(iii).

Intervenors are submitting this new information pursuant to the April 2, 2019 Scheduling Order. It is therefore timely for this reason alone. The expert opinions are also timely because they rely on the new data described above, which for reasons explained there, are being brought forward in a timely manner.

D. <u>NEW CONTENTION 6-E</u>: The DSEIS Fails to Take the Requisite "Hard Look" at the Impacts on Surface Waters via the Groundwater Pathway.

1. Statement of the issue of law or fact to be raised or controverted (10 C.F.R. § 2.309(f)(1)(i).

The DSEIS violates NEPA's requirement to take a "hard look" at the environmental impacts of the proposed action because its evaluation of impacts on nearby surface waters via the groundwater pathway is inadequate. The DSEIS's conclusion that these impacts will be SMALL is unsupported by and contrary to the evidence and unlawfully substitutes the existence of permit requirements and oversite for a proper NEPA analysis.

2. Brief explanation of the basis for the contention. 10 C.F.R. § 2.309(f)(ii).

When conducting a NEPA analysis of a model's outputs, an agency must take into consideration the environmental implications and impacts of inaccurate results. If an agency bases its decision on an unreliable model that has shown to provide insufficient or incorrect information, then they have failed to employ the required "hard look" imposed by NEPA.[169]

The DSEIS fails to comply with NEPA's "hard look" requirement for precisely this reason. In section 4.5.1.1 of the DSEIS, the NRC Staff conclude that impacts on adjacent surface water bodies via the groundwater pathway from the cooling canal system during the subsequent license renewal term would be SMALL, and therefore new information identified by

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[169] *Lands Council v. Powell*, 395 F.3d 1019, 1035 (9th Cir. 2005).

the NRC staff is not significant.[170] In reaching this conclusion, however, the NRC staff relied on "the FDEP's and DERM's existing requirements and their continuing oversight of FPL's site remediation efforts,"[171] and this reliance is misplaced.

The DSEIS recognizes that Applicant's efforts to reduce salinity in the cooling canal system through the addition of water pumped from the Upper Floridan aquifer have been unsuccessful.[172] This effort to "freshen" the cooling canal system did not achieve the 34 PSU annual average as predicted by Applicant's modelers. Those modelers, according to the DSEIS, suggested that more favorable climatic conditions should help to achieve the desired salinity.[173] But this statement is not supported by any effort to determine what climatic conditions would be necessary to achieve the salinity target, or whether these necessary climatic conditions will or are likely to exist during the subsequent license renewal period. Without this necessary information, the DSEIS is simply assuming that continued oversight by state and county regulators will produce a solution to address environmental impacts from the cooling canal system. But the mere "existence of permit requirements overseen by another . . . state permitting authority cannot substitute for a proper NEPA analysis."[174]

The new reports and expert opinions provided by Intervenors in support of Contention 6-E, on the other hand, further demonstrate that Applicant's remedial and freshening efforts are not sufficient to address environmental impacts from the cooling canal system now or in the

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[170] DSEIS at 4-23.

[171] *Id.*

[172] *Id.* at 3-49.

[173] *Id.*

[174] *Sierra Club v. Fed. Energy Regulatory Comm'n*, 867 F.3d 1357, 1375 (D.C. Cir. 2017) (citing *Calvert Cliffs' Coordinating Comm. V. Atomic Energy Comm'n*, 449 F.2d 1109, 1122–23 (D.C. Cir. 1971).

future.[175] Further, recent data demonstrates that the cooling canal system has degraded nearby surface waters and placed vital seagrass communities in jeopardy from phosphorus loadings attributable to the cooling canal system.[176] This is in contrast to information presented in the DSEIS indicating otherwise.[177]

3. The issue raised in the contention is within the scope of the proceeding. 10 C.F.R. § 2.309(f)(iii).

NRC regulations broadly divide the scope of a license renewal proceeding into (1) safety/aging management issues, and (2) environmental impacts. The scope of the required environmental review is specifically established by 10 C.F.R. Part 51 and the GEIS for license renewals.[178] The GSEIS generically resolves certain "Category 1" issues, such that they are "beyond the scope of a license renewal hearing."[179]

Contention 6-E is within the scope of the proceeding. It challenges conclusions about environmental impacts that are not supported by the evidence in the DSEIS. Further, it addresses a "new site-specific issue that has been identified [by the NRC Staff] for Turkey Point,"[180] and therefore the Category 1 prohibition does not apply.

4. The issue raised in the contention is material to the findings the NRC must make to support the action involved in the proceeding. 10 C.F.R. § 2.309(f)(1)(iv).

A contention is "material" to the NRC's duty to make environmental findings if the issue of law or fact it raises "is of possible significance to the result of the proceeding. This means that

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[175] *See* Section IV.B, above.

[176] *Id.*

[177] DSEIS at 4-23.

[178] *Entergy Nuclear Vermont Yankee, LLC* (Vermont Yankee), LBP-06-20, 64 NRC 131, 148-49 (2006).

[179] *Florida Power & Light Co.* (Turkey Point Nuclear Generating Plant, Units 3 and 4), CLI-01-17, 54 NRC 3, 15 (July 19, 2001); *see* 10 C.F.R. § 51.53(c)(3)(i).

[180] DSEIS at 4-23 (describing this as a "new site-specific issue that has been identified for Turkey Point").

there should be some significant link between the claimed deficiency and either the health and safety of the public or the environment."[181] The issue raised in this contention relates directly to the NRC's role in protecting public health and safety and the environment. NEPA imposes requirements on the NRC to ensure environmental protection. The failure to comply with these requirements is material to the findings NRC must make to support relicensing.

5. **Provide a concise statement of the alleged facts or expert opinions which support the petitioner's position on the issue and on which the petitioner intends to rely at the hearing, together with references to the specific sources and documents on which the petitioner intends to rely to support its position on the issue. 10 C.F.R. § 2.309(f)(1)(v).**

See section IV.B, above.

6. **Provide sufficient information to show that a genuine dispute exists on a material issue of law or fact. This information must include references to specific portions of the application that the petitioner disputes and the supporting reasons for each dispute, or, if the petitioner believes that the application fails to contain information on a relevant matter as required by law, the identification of each failure and the supporting reasons for the petitioner's belief. 10 C.F.R. § 2.309(f)(1)(vi).**

Intervenors dispute the NRC Staff's conclusion in section 4.5.1.1 of the DSEIS that impacts on adjacent surface water bodies via the groundwater pathway from the cooling canal system during the subsequent license renewal term would be SMALL.[182]

The NRC Staff's conclusion presumes that compliance with the FDEP Consent Order and the Miami-Dade Consent Agreement will effectively manage salinity conditions in the cooling canal system and therefore prevent adverse impacts on adjacent surface water bodies. The Staff's conclusion, however, is based on numerical modeling that has proven unreliable and

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[181] *In re Entergy Nuclear Vt. Yankee L.L.C. & Entergy Nuclear Operations*, 60 N.R.C. 548, 556, 2004 NRC LEXIS 247, *16-17 (N.R.C. November 22, 2004).

[182] DSEIS at 4-23.

unsupported assertions by Applicant's modelers that more favorable climatic conditions will resolve the problem.[183] Intervenors offer evidence and expert opinions that Applicant's ongoing efforts to manage salinity issues are not, and will not, reach required target salinity levels or effectively remediate the hypersaline plume.[184]

The DSEIS also describes the existing impacts on adjacent waterbodies via the groundwater pathway as minimal or undetected.[185] Intervenors offer Dr. Fourqurean's report, which demonstrates impacts on water quality in Biscayne Bay via the groundwater pathway are impacting seagrass communities and that continued operation of the cooling canal system is likely to violate narrative water quality standards.[186]

Intervenors have, therefore, provided sufficient information to establish a genuine dispute exists on a material issue of fact or law. The environmental impacts from continued operation of Units 3 and 4 during the subsequent licensing period will not result in SMALL impacts.

E. New Contention 7-E: The DSEIS Fails to Take the Requisite "Hard Look" at Impacts to Groundwater Quality.

1. Statement of the issue of law or fact to be raised or controverted (10 C.F.R. § 2.309(f)(1)(i).

The DSEIS violates NEPA's requirement to take a "hard look" at the environmental impacts of the proposed action because its evaluation of groundwater quality degradation is inadequate. Contention 7-E is limited to those conclusions regarding the "new information" that the NRC Staff identified and evaluated in the DSEIS.[187] The Staff concluded that "site-specific

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[183] DSEIS at 3-49.

[184] *See* Section IV.B, above.

[185] DSEIS at 4-23.

[186] *See* Section IV.B.5, above.

[187] DSEIS at 4-2.

impacts for this issue at the Turkey point site are MODERATE for current operations, but will be SMALL during the subsequent license renewal term."[188] These conclusions doo not satisfy the "hard look" requirement because they are unsupported by the evidence, contrary to the evidence including evidence provided by Intervenors, and unlawfully substitute the existence of state and county requirements and oversite for a proper NEPA analysis.

2. Brief explanation of the basis for the contention. 10 C.F.R. § 2.309(f)(ii).

NEPA and NRC regulations require a "hard look" at the environmental consequences of the proposed action.[189] Under the NRC's NEPA regulations, this analysis may rely on "conclusions as amplified by the information in the GEIS for issues designated as Category 1.[190] There is no NRC regulation, however, that prohibits Intervenors from challenging new information identified and evaluated by the NRC Staff in a DSEIS with respect to a Category 1 issue.

Here, the DSEIS provides in section 4.5.1.2 that "the NRC staff has concluded that the site-specific impacts for [groundwater quality impacts] at the Turkey point site are MODERATE for current operations, but will be SMALL during the subsequent license renewal term as a result of ongoing remediation measures and State and county oversight, now in place at Turkey point."[191] The NRC Staff's conclusion that impacts to groundwater will be SMALL during the subsequent license renewal term is not supported by the facts and is flawed for the reasons described in Section IV.D.2, above. Because the remediation/freshening efforts are not working, and are not expected to work in the future, the impacts to groundwater will be either

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[188] DSEIS at 4-27.

[189] *Sierra Club v. Fed. Energy Regulatory Comm'n*, 867 F.3d 1357, 1367 (D.C. Cir. 2017); 40 C.F.R. § 1502.16; 10 C.F.R. 51.71(d).

[190] 10 C.F.R. § 51.71(d).

[191] DSEIS at 4-27.

MODERATE or LARGE.

3. The issue raised in the contention is within the scope of the proceeding. 10 C.F.R. § 2.309(f)(iii).

NRC regulations broadly divide the scope of a license renewal proceeding into (1) safety/aging management issues, and (2) environmental impacts. The scope of the required environmental review is specifically established by 10 C.F.R. Part 51 and the GEIS for license renewals.[192] The GSEIS generically resolves certain "Category 1" issues, such that they are "beyond the scope of a license renewal hearing."[193]

Contention 7E is within the scope of the proceeding. It challenges conclusions about environmental impacts that are not supported by the evidence in the DSEIS. Further, it addresses site-specific "new and significant" information that NRC Staff identified and analyzed on its own accord.

4. The issue raised in the contention is material to the findings the NRC must make to support the action involved in the proceeding. 10 C.F.R. § 2.309(f)(1)(iv).

The issue raised in this contention is within the scope of the proceeding for the same reasons as expressed in IV.D.4, above.

5. Provide a concise statement of the alleged facts or expert opinions which support the petitioner's position on the issue and on which the petitioner intends to rely at the hearing, together with references to the specific sources and documents on which the petitioner intends to rely to support its position on the issue. 10 C.F.R. § 2.309(f)(1)(v).

See section IV(B), above.

6. Provide sufficient information to show that a genuine dispute exists on a material issue of law or fact. This information must include references to specific portions of the application that the petitioner disputes and the supporting reasons for each dispute, or, if the petitioner believes that the

[192] *Entergy Nuclear Vermont Yankee, LLC* (Vermont Yankee), LBP-06-20, 64 NRC 131, 148-49 (2006).

[193] *Florida Power & Light Co.* (Turkey Point Nuclear Generating Plant, Units 3 and 4), CLI-01-17, 54 NRC 3, 15 (July 19, 2001); *see* 10 C.F.R. § 51.53(c)(3)(i).

application fails to contain information on a relevant matter as required by law, the identification of each failure and the supporting reasons for the petitioner's belief. 10 C.F.R. § 2.309(f)(1)(vi).

Intervenors contest the NRC Staff's conclusion in section 4.5.1.2 of the DSEIS that new and significant information it identified for groundwater quality impacts from the cooling canal system during the subsequent license renewal term would be SMALL.[194] The NRC Staff concludes that current impacts are MODERATE, the Staff concluded that impacts "will be SMALL during the subsequent license renewal term as result of ongoing remediation measures and State and county oversight, now in place at Turkey Point."[195] For the reasons stated in Section IV.D.6 above, including referenced expert opinions, the Staff's conclusion that impacts will be SMALL during the subsequent license renewal period is unsupported by the evidence, is contrary to the evidence including evidence provided by Intervenors, and unlawfully substitutes the existence of state and county requirements and oversite for a proper NEPA analysis.

Intervenors have, therefore, provided sufficient information to establish a genuine dispute exists on a material issue of fact or law. The environmental impacts from continued operation of Units 3 and 4 during the subsequent licensing period will not result in SMALL impacts on groundwater quality.

F. <u>NEW CONTENTION 8-E</u>: The DSEIS Fails to Take the Requisite "Hard Look" at Cumulative Impacts on Water Resources.

1. Statement of the issue of law or fact to be raised or controverted (10 C.F.R. § 2.309(f)(1)(i).

The DSEIS violates NEPA's requirement to take a "hard look" at the cumulative environmental impacts of the proposed subsequent license renewal for water resources. This

[194] DSEIS at 4-27.

[195] *Id.*

conclusion is unsupported by the evidence, is contrary to the evidence including evidence provided by Intervenors, and unlawfully substitutes the existence of state and county requirements and oversite for a proper NEPA analysis.

2. Brief explanation of the basis for the contention. 10 C.F.R. § 2.309(f)(ii).

The DSEIS violates NEPA's requirement to take a "hard look" at the cumulative environmental impacts with respect to water resources. The evaluation of cumulative impacts is a Category 2 issue that is subject to site-specific analysis. In section 4.16.2.1 of the DSEIS, the NRC Staff concludes that Applicant's recovery well system will be "successful" in retracting the hypersaline plume before the end of the current license period and "result in beneficial impacts on groundwater quality within the Biscayne aquifer. . . ."[196] In addition, the NRC Staff:

> expects the continued operation of the freshening system, combined with proper operation and maintenance of the [cooling canal system], will result in no substantial contribution to cumulative impacts on groundwater quality or associated impacts on surface water quality in Biscayne Bay during the subsequent license renewal period.[197]

The basis for this Contention mirror those in Sections IV.D.2 and IV.E.2, above, which are incorporated here by reference.

3. The issue raised in the contention is within the scope of the proceeding. 10 C.F.R. § 2.309(f)(iii).

NRC regulations broadly divide the scope of a license renewal proceeding into (1) safety/aging management issues, and (2) environmental impacts. The scope of the required environmental review is specifically established by 10 C.F.R. Part 51 and the GEIS for license renewals.[198] Contention 8-E is within the scope of the proceeding. It challenges conclusions

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[196] DSEIS at 4-116 – 117.

[197] DSEIS at 4-117.

[198] *Entergy Nuclear Vermont Yankee, LLC* (Vermont Yankee), LBP-06-20, 64 NRC 131, 148-49 (2006).

about environmental impacts that are not supported by the evidence in the DSEIS. Further, it addresses a Category 2 issue—cumulative impacts.

4. **The issue raised in the contention is material to the findings the NRC must make to support the action involved in the proceeding. 10 C.F.R. § 2.309(f)(1)(iv).**

The issue raised in this contention is within the scope of the proceeding for the same reasons as expressed in IV.D.4, above.

5. **Provide a concise statement of the alleged facts or expert opinions which support the petitioner's position on the issue and on which the petitioner intends to rely at the hearing, together with references to the specific sources and documents on which the petitioner intends to rely to support its position on the issue. 10 C.F.R. § 2.309(f)(1)(v).**

See section IV.B, above.

6. **Provide sufficient information to show that a genuine dispute exists on a material issue of law or fact. This information must include references to specific portions of the application that the petitioner disputes and the supporting reasons for each dispute, or, if the petitioner believes that the application fails to contain information on a relevant matter as required by law, the identification of each failure and the supporting reasons for the petitioner's belief. 10 C.F.R. § 2.309(f)(1)(vi).**

Intervenors contest the NRC Staff's conclusions in section 4.16.2.1 of the DSEIS regarding cumulative impacts to water resources as referenced in Section IV.F.1, above. These conclusions rely on the success of Applicant's remediation and freshening efforts. As discussed above in Section IV.D.6 and IV.E.6, Intervenors have provided evidence and expert opinions contesting the NRC Staff's reliance on Applicant's remediation and freshening efforts. This evidence, which Intervenors incorporate here by reference, demonstrate a genuine dispute on a material issue of law or fact regarding the cumulative impacts analysis for water resources. The Staff's analysis is unsupported by the evidence, contrary to the evidence including evidence provided by Intervenors, and unlawfully substitutes the existence of state and county requirements and oversite for a proper NEPA analysis.

G. <u>New Contention 9-E:</u> The DSEIS Fails to Take the Requisite "Hard Look" at Impacts to Groundwater Use Conflicts.

1. Statement of the issue of law or fact to be raised or controverted (10 C.F.R. § 2.309(f)(1)(i).

The DSEIS violates NEPA's requirement to take a "hard look" at the environmental impacts of the proposed action because its evaluation of impacts of groundwater use conflicts is inadequate. This conclusion is unsupported by the evidence, is contrary to the evidence including evidence provided by Intervenors, and unlawfully substitutes the existence of state and county requirements and oversite for a proper NEPA analysis.

2. Brief explanation of the basis for the contention. 10 C.F.R. § 2.309(f)(ii).

The DSEIS violates NEPA's requirement to take a "hard look" at groundwater use conflicts from the proposed subsequent relicensing application.

The DSEIS concludes that these impacts will be SMALL for the Biscayne aquifer and MODERATE for the Upper Floridan aquifer during the subsequent license renewal term.[199] This conclusion does not satisfy the "hard look" requirement because it is unsupported by the evidence, is contrary to the evidence, including evidence provided by Intervenors, and unlawfully substitutes the existence of state and county requirements and oversite for a proper NEPA analysis.

3. The issue raised in the contention is within the scope of the proceeding. 10 C.F.R. § 2.309(f)(iii).

NRC regulations broadly divide the scope of a license renewal proceeding into (1) safety/aging management issues, and (2) environmental impacts. The scope of the required environmental review is specifically established by 10 C.F.R. Part 51 and the GEIS for license

[199] DSEIS at 4-33.

renewals.[200] Contention 8E is within the scope of the proceeding. It challenges conclusions about environmental impacts that are not supported by the evidence in the DSEIS. Further, it addresses a Category 2 issue—groundwater use conflicts.

4. **The issue raised in the contention is material to the findings the NRC must make to support the action involved in the proceeding. 10 C.F.R. § 2.309(f)(1)(iv).**

The issue raised in this contention is within the scope of the proceeding for the same reasons as expressed in IV.D.4, above.

5. **Provide a concise statement of the alleged facts or expert opinions which support the petitioner's position on the issue and on which the petitioner intends to rely at the hearing, together with references to the specific sources and documents on which the petitioner intends to rely to support its position on the issue. 10 C.F.R. § 2.309(f)(1)(v).**

See section IV.B, above.

6. **Provide sufficient information to show that a genuine dispute exists on a material issue of law or fact. This information must include references to specific portions of the application that the petitioner disputes and the supporting reasons for each dispute, or, if the petitioner believes that the application fails to contain information on a relevant matter as required by law, the identification of each failure and the supporting reasons for the petitioner's belief. 10 C.F.R. § 2.309(f)(1)(vi).**

Intervenors contest the NRC Staff's conclusion in section 4.5.1.2 of the DSEIS that impacts from the proposed subsequent license renewal on groundwater use conflicts will be SMALL with respect to the Biscayne aquifer and MODERATE with respect to the Upper Floridan aquifer.[201] These conclusions are based on analyses performed by Applicant suggesting that "current and projected groundwater withdrawals associated with [Applicant's] operation of its Biscayne aquifer marine well and recovery well systems would be unlikely to have any

[200] *Entergy Nuclear Vermont Yankee, LLC* (Vermont Yankee), LBP-06-20, 64 NRC 131, 148-49 (2006).

[201] DSEIS at 4-33.

noticeable, adverse impact on any supply wells beyond the confines of the Turkey Point site."[202] The Staff's conclusion is based on modeled projections on drawdown impacts and salinity reductions through operation of the recovery well system.[203] These, in turn, rely on the presumption that Applicant's current groundwater withdrawal rates will remain the same (or lower) and that the ongoing effort to mitigate the hypersaline plume will achieve its objectives. The DSEIS also relies on an unsubstantiated statement that Applicant "does not anticipate the need to withdraw groundwater at a rate exceeding its current permits and/or authorizations during the subsequent license renewal period."[204]

Intervenors contest this conclusion with evidence demonstrating that current effort to mitigate the hypersaline plume and reduce salinity in the cooling canal system to 34 PSU are not working and are unlikely to work in the future.[205] Retraction of the hypersaline plume is not likely to occur without the addition of more wells and increased pumped volumes.[206] Existing analyses referenced in the DSEIS are therefore inadequate to support the Staff's conclusions on groundwater use conflicts because the rate of groundwater withdrawal necessary to hit salinity targets and retract the hypersaline plume is substantially higher than evaluated in the DSEIS.[207] Thus, Intervenors have provided sufficient information in support of this contention to establish a genuine dispute exists on a material issue of fact or law.

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[202] DSEIS at 4-32.

[203] DSEIS at 4-32.

[204] DSEIS at 4-33.

[205] *See* Sections IV.B, above.

[206] Wexler Decl. at 2.

[207] *See* Wexler Decl. at 2.

CONCLUSION

For the foregoing reasons, Intervenors have demonstrated that their updated contentions and new contention are admissible, and they are entitled to a hearing on these contentions.

Respectfully submitted,

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June 24, 2019

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	
FLORIDA POWER & LIGHT COMPANY	)	Docket No. 50-250-SLR
	)	Docket No. 50-251-SLR
(Turkey Point Nuclear Generating Station, Unit Nos. 3 and 4)	)	
	)	June 24, 2019
	)	

CERTIFICATE OF SERVICE

I certify that on June 24, 2019, I posted copies of the foregoing NATURAL RESOURCES DEFENSE COUNCIL'S, FRIENDS OF THE EARTH'S, AND MIAMI WATERKEEPER'S MOTION TO MIGRATE CONTENTIONS & ADMIT NEW CONTENTIONS IN RESPONSE TO NRC STAFF'S SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT on NRC's Electronic Information Exchange System.

/signed electronically by/ Kenneth Rumelt

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	
FLORIDA POWER & LIGHT COMPANY	)	Docket No. 50-250-SLR
	)	Docket No. 50-251-SLR
(Turkey Point Nuclear Generating Station, Unit Nos. 3	)	
and 4)	)	June 24, 2019
	)	

NATURAL RESOURCES DEFENSE COUNCIL'S, FRIENDS OF THE EARTH'S, AND MIAMI WATERKEEPER'S PETITION FOR WAIVER OF 10 C.F.R. §§ 51.53(C)(3) AND 51.71(D) AND 10 C.F.R. PART 51, SUBPART A, APPENDIX B

Pursuant to 10 C.F.R. § 2.335(b), Natural Resources Defense Council, Friends of the Earth, and Miami Waterkeeper (together "Intervenors") hereby petition for a limited waiver of 10 C.F.R. §§ 51.53(c)(3) and 51.71(d) and 10 C.F.R. Part 51, Subpart A, Appendix B to the extent the Atomic Safety and Licensing Board ("Board") interprets those regulations to preclude Intervenors from submitting new contentions 6E and 7E challenging the NRC Staff's analysis in the Draft Supplemental Environmental Impact Statement for subsequent license renewal regarding Turkey Point, Units 3 and 4 ("DSEIS")[1] regarding two issues: (1) groundwater quality degradation (plants with cooling ponds in salt marshes) and (2) water quality impacts on adjacent water bodies (plants with cooling ponds in salt marshes).[2] This waiver request is supported by

[1] NUREG-1437, Supp. 5, Second Renewal, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 5, Second Renewal, Regarding Subsequent License Renewal for Turkey Point Nuclear Generating Unit Nos. 3 and 4, Draft Report for Comment" (Mar. 2019) (ML19078A330) ("DSEIS").

[2] By this Petition, Intervenors seek a waiver of any other rules or regulations in addition to 10 C.F.R. § 51.53(c)(3) and 10 C.F.R. Part 51, Subpart A, Appendix B to the extent the Board interprets those regulations to preclude Intervenors from submitting new contentions challenging the analysis in the DSEIS regarding the issues described above.

the attached Declaration of Friends of the Earth's counsel, Kenneth Rumelt ("Rumelt Decl.").

I. INTRODUCTION AND BACKGROUND

On August 1, 2018 and pursuant to 10 C.F.R. § 2.309 and the NRC's Federal Register notice published at 83 Fed. Reg. 19,304 (May 2, 2018), Intervenors submitted a Request for Hearing and Petition to Intervene[3] in the above-captioned matter. To safeguard our and our members' environmental, aesthetic, health-based and economic interests, Intervenors articulated five contentions in the Petition. These contentions addressed various deficiencies in Florida Power & Light Co.'s ("Applicant") Environmental Report, submitted as part of the subsequent renewal license application for Turkey Point Nuclear Generating Station, Units 3 and 4, in Miami-Dade County, Florida.

Following full briefing and a hearing on the admissibility of each contention, the Board on March 7, 2019 issued Memorandum and Order LBP-19-3 granting Intervenors' hearing request ("Order").[4] In that Order, the Board also found that Intervenors had established standing and admitted in part two of the five contentions. The Board then issued, and subsequently amended, a scheduling order that provided Intervenors the opportunity to review initial disclosures provided by the parties and then rely on them to file new and amended contentions.[5]

On April 1, 2019, Applicant filed an appeal of the Order,[6] and on April 26, 2019,

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[3] Request for Hearing and Petition to Intervene Submitted by Friends of the Earth, Natural Resources Defense Council, and Miami Waterkeeper (Aug. 1, 2018) (ML18212A418) ("Petition to Intervene").

[4] *Fla. Power & Light Co.* (Turkey Point Nuclear Generating Station Units 3 & 4), LBP-19-3, 89 N.R.C. __ (slip op.) (Mar. 7, 2019) ("Order").

[5] Initial Scheduling Order at 3 (establishing the deadline to file new and amended contentions as 45 days following the later of the issuance of the DSEIS or the Initial Disclosures) (Mar. 21, 2019); Order (Granting in Part Intervenors' Joint Motion for Partial Reconsideration of Initial Scheduling Order) (Apr. 2, 2019).

[6] Florida Power & Light Company's Appeal of LBP-19-3 (Apr. 1, 2019) (ML19091A302) ("Appeal"). FPL did not challenge Intervenors' standing before the Commission.

Intervenors opposed the appeal.[7] The NRC Staff agreed with Intervenors that the Board had correctly admitted the contentions.[8] This appeal is pending before the Commission.

In March 2019, NRC Staff issued the DSEIS. Based on the DSEIS, on May 20, 2019, Applicant filed two motions to dismiss Intervenors' contentions as moot.[9] On June 10, 2019, Intervenors opposed these motions,[10] and the NRC Staff supported them.[11] These motions are currently pending before the Board. Intervenors timely filed comments on the DSEIS on May 20, 2019.[12]

Today, Intervenors timely filed amended and new contentions based on the DSEIS. Among other issues, the new contentions concern the NRC Staff's analysis of "new and significant" information for one existing Category 1 issue (groundwater quality degradation (plants with cooling ponds in salt marshes)) and one "new issue" that is neither Category 1 nor 2 (water quality impacts on adjacent water bodies (plants with cooling ponds in salt marshes)).[13]

This Petition for Waiver requests a waiver of 10 C.F.R. §§ 51.53(c)(3) and 51.71(d) and 10 C.F.R. Part 51, Subpart A, Appendix B ("Appendix B") to the extent those the Board interprets those regulations to preclude Intervenors from submitting Contentions 6E and 7E

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[7] Opposition of Natural Resources Defense Council, Friends of the Earth, and Miami Waterkeeper to Florid Power & Light Company's Appeal of the Atomic Safety and Licensing Board's Ruling in LBP-19-3 (Apr. 26, 2019) (ML19116A229).

[8] NRC Staff's Brief in Response to Florida Power & Light Company's Appeal of LBO-19-3 (Apr. 26, 2019) (ML19116A272).

[9] FPL's Motion to Dismiss Joint Petitioners' Contention 1-E as Moot (May 20, 2019) (ML19140A355); FPL's Motion to Dismiss Joint Petitioners' Contention 5-E as Moot (May 20, 2019) (ML19140A356).

[10] Joint Petitioners' Answer Opposing FPL's Motion to Dismiss Joint Petitioners' Contention 1-E as Moot (June 10, 2019); Joint Petitioners' Answer Opposing FPL's Motion to Dismiss Joint Petitioners' Contention 5-E as Moot (June 10, 2019).

[11] NRC Staff's Answer to FPL's Motions to Dismiss (June 10, 2019).

[12] NRDC, FOE, and Miami Waterkeeper Comments on Draft Supplemental Environmental Impact Statement for Turkey Point Nuclear Generating Units Nos. 3 and 4 (May 20, 2019).

[13] *See, e.g.,* DSEIS at 4-2, 4-27.

challenging the analysis in the DSEIS regarding (1) groundwater quality degradation (plants with cooling ponds in salt marshes) and (2) water quality impacts on adjacent water bodies (plants with cooling ponds in salt marshes).

II. STATUTORY AND REGULATORY FRAMEWORK

a. The Scope of a License Renewal Proceeding

A license renewal application review typically implicates issues that fall into one of two broad areas: safety/aging management issues, and public health/environmental impacts. Intervenors' new contentions focus on environmental and public health impacts. The scope of the environmental review is defined by 10 C.F.R. Part 51, the NRC's "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," NUREG- 1437 (May 1996) (the "GEIS"), and the initial hearing notice and order.[14]

Some environmental issues that might otherwise be germane in an initial license renewal proceeding have been resolved generically for all plants and are normally, therefore, "beyond the scope of a license renewal hearing."[15] These "Category 1" issues are classified in 10 C.F.R. Part 51, Subpart A, Appendix B.

b. Standards for Waiver of Application of NRC Rule or Regulation

Under 10 C.F.R. § 2.335(b), any "participant to an adjudicatory proceeding . . . may petition that the application of a specified Commission rule or regulation or any provision thereof . . . be waived or an exception be made for the particular proceeding." Section 2.335(b) further provides that "[t]he sole ground for petition of waiver or exception is that special circumstances

[14] *See, e.g., Vermont Yankee*, 64 N.R.C. at 148–49.

[15] *Florida Power & Light Co.* (Turkey Point Nuclear Generating Plant, Units 3 and 4), CLI-01-17, 54 NRC 3, 15 (July 19, 2001); *see* 10 C.F.R. § 51.53(c)(3)(i). Intervenors explicitly reassert and do not waive their argument that 10 C.F.R. § 51.53(c)(3)'s provision exempting a license renewal applicant's environmental report from addressing Category 1 issues applies only to an initial license renewal, as made clear by the provision's plain terms, and does not apply to a subsequent license renewal proceeding.

with respect to the subject matter of the particular proceeding are such that the application of the rule or regulation (or a provision of it) would not serve the purposes for which the rule or regulation was adopted."[16]

In interpreting § 2.335(b), the Commission has articulated a four-factor test, sometimes referred to as the *Millstone* factors, which a waiver petitioner must satisfy.[17] To set aside a Commission rule or regulation in an adjudicatory proceeding, a petitioner must demonstrate that:

> (i) the rule's strict application would not serve the purposes for which it was adopted;
>
> (ii) special circumstances exist that were not considered, either explicitly or by necessary implication, in the rulemaking proceeding leading to the rule sought to be waived;
>
> (iii) those circumstances are unique to the facility rather than common to a large class of facilities; and
>
> (iv) waiver of the regulation is necessary to reach a significant safety [or environmental][18] problem.[19]

All four *Millstone* factors must be met to justify a rule waiver.[20]

III. ARGUMENT

a. NRC Regulations Do Not Require a Waiver in Order to Challenge the DSEIS's Analysis in This Instance

For the reasons below, the requested waiver is not necessary in order for Intervenors to assert new contentions regarding groundwater quality degradation (plants with cooling ponds in

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[16] 10 C.F.R. § 2.335(b).

[17] *Dominion Nuclear Connecticut, Inc*. (Millstone Nuclear Power Station, Units 2 and 3), CLI-05-24, 62 NRC 551, 559-60 & nn. 29-34 (2005).

[18] *See Exelon Generation Co., LLC* (Limerick Generation Station, Units 1 and 2), CLI-13-07, 2013 WL 5872241 (Oct. 31, 2013), at *4 ("clarify[ing] . . . that the fourth *Millstone* factor also may apply to a significant environmental issue").

[19] *Id.*

[20] *Id.*

salt marshes) or water quality impacts on adjacent water bodies (plants with cooling ponds in salt marshes).

Groundwater quality degradation (plants with cooling ponds in salt marshes).[21] No NRC regulation prohibits Intervenors from challenging new information identified and evaluated by the NRC Staff in a DSEIS with respect to a Category 1 issue. A waiver, therefore, is not necessary to submit a contention challenging the adequacy of the DSEIS's analysis regarding this issue.[22]

Water quality impacts on adjacent water bodies (plants with cooling ponds in salt marshes).[23] As the NRC Staff recognized in the DSEIS, this issue is neither Category 1 nor Category 2.[24] No NRC regulation prohibits Intervenors from challenging new information identified and evaluated by the NRC Staff in a DSEIS with respect to an issue that is neither Category 1 nor Category 2. A waiver, therefore, is not necessary to submit a contention challenging the adequacy of the DSEIS's analysis regarding this issue.

In an abundance of caution, however, Intervenors submit this Petition requesting the Board to waive application of Sections 51.53(c)(3) and 51.71(d) and Appendix B and any other rules or regulations that the Board interprets to prohibit Intervenors from challenging the adequacy of the DSEIS's analysis (including analysis of new information) regarding these issues.

b. Intervenors Satisfy the Criteria for a Waiver

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[21] *See* DSEIS at 4-24 to 4-28.

[22] *See* Order at 27 (A DSEIS must "address any new and significant information of which it becomes aware, which might affect the applicability of the Commission's generic Category 1 determinations in the proceeding."); *id.* at n.102 (citing cases); *Deukmejian v. NRC*, 751 F.2d 1287, 1298 (D.C. Cir. 1984) (explaining that "The [NRC's] obligations under NEPA [include] a continuing duty to supplement EISs which have already become final whenever the discovery of significant new information renders the original EIS inadequate").

[23] *See* DSEIS at 4-21 to 4-23.

[24] DSEIS at 4-21 to 4-22.

Petitioners have satisfied the requirements of 10 C.F.R. § 2.335(b) and *Millstone*. Each of the four *Millstone* factors weighs in favor of issuing the requested waiver.

i. Strict Application of the Regulations Would Not Serve the Purposes for Which They Were Adopted (*Millstone* Factor 1)

Application of Sections 51.53(c)(3) and 51.71(d) and Appendix B in this case to preclude Intervenors from asserting Contentions 6E and 7E would unjustifiably prevent Intervenors from challenging the sufficiency of the DSEIS's analysis of new information. The DSEIS's analysis of the two issues referenced above is the first analysis to address this new information in the subsequent license renewal proceeding. Intervenors (and more broadly, the public) have not yet had an opportunity to review or challenge the sufficiency of this information. Interpreting Sections 51.53(c)(3) and 51.71(d) and Appendix B to prevent challenges to analysis of new information would be contrary to NEPA's requirement that agencies "broad[ly] disseminat[e]" information to "permit[] the public and other government agencies to react to the effects of a proposed action at a meaningful time."[25]

Interpreting sections 51.53(c)(3) and 51.71(d) and Appendix B to prevent challenges to analysis of new information would not serve the purposes of the NRC's regulatory scheme providing for generic resolution of certain issues (Category 1) and site-specific resolution of others (Category 2). The requirement to prepare a supplement to a GEIS is intended to ensure that "[w]hen the GEIS and SEIS are combined, they cover all issues that NEPA requires be addressed in an EIS for a nuclear power plant license renewal proceeding."[26] Allowing a petitioner to challenge the adequacy of analysis pertaining to new information regarding a Category 2 issue while preventing such a challenge with respect to new information regarding a

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[25] *Marsh v. Or. Natural Res. Council*, 490 U.S. 360, 371 (1989).

[26] *Massachusetts v. United States*, 522 F.3d 115, 120 (1st Cir. 2008).

Category 1 issue (or, in the case of water quality impacts to adjacent water bodies, an entirely new issue that is neither Category 1 nor 2) would not serve the purposes for which sections 51.53(c)(3) and 51.71(d) and Appendix B were adopted.

ii. Special Circumstances Exist That are Unique to Turkey Point and That Were Not Considered in the Rulemaking Proceeding Limiting the Scope of SEISs Regarding Subsequent License Renewal (*Millstone* Factors 3 and 4)

Turkey Point Units 3 and 4 have a long and well-documented history of impacts to groundwater and surface water caused by the Units' cooling canal system and the hypersaline plume that has resulted from operation of the system.[27] These impacts have resulted in numerous enforcement actions by state and county regulators and the requirement that the Applicant engage in extraordinary measures to mitigate those harms. Turkey Point is the only nuclear generating unit that uses a cooling canal system. No other nuclear generating unit's cooling system has resulted in a hypersaline plume that has migrated through groundwater, threatening local drinking supplies. These impacts are undoubtedly "special circumstances" meriting the requested waiver.

It is beyond dispute that, in either the rulemaking proceeding concerning the scope of environmental review required for a subsequent license renewal or the GEIS prepared for subsequent license renewal proceedings, the NRC did not consider issues of salinity in cooling canals or the possibility that operation of a cooling canal system might result in a hypersaline plume migrating through surrounding groundwater. The DSEIS itself recognized that the GEIS "did not consider how a nuclear power plant with a cooling pond in a salt marsh may indirectly impact the water quality of adjacent surface water bodies via a groundwater pathway" and that

[27] *See* DSEIS at 3-46 to 3-49, 3-56 to 3-73.

the issue "constitutes a new, site-specific issue with respect to Turkey Point."[28] Special circumstances exist that are unique to Turkey Point and that were not considered in either the rulemaking proceeding limiting the scope of an environmental review for subsequent license renewal proceedings or the GEIS issued for subsequent license renewal proceedings.

iii. Waiver is Necessary to Reach a Significant Environmental Issue (*Millstone* Factor 4)

Waiver is necessary to permit Intervenors to raise new information regarding the environmental impacts of the hypersaline plume on groundwater and adjacent surface water—undoubtedly a significant environmental issue.[29] The hypersaline plume poses a significant threat to surrounding natural resources. The DSEIS recognizes that the saltwater interface has advanced inland west and north from Turkey Point at an average rate of 460 feet per year, threatening the drinking water source for a large portion of South Florida.[30] To mitigate these impacts, Applicant has been forced to take extensive (but largely unsuccessful) measures to halt the advance of the hypersaline plume. Waiver of these regulations is necessary to reach this significant environmental issue because Intervenors have no other avenue by which it can assert that the DSEIS's analysis of new information is insufficient.

IV. CONCLUSION

For these reasons, Intervenors respectfully request a waiver of 10 C.F.R. §§ 51.53(c)(3) and 51.71(d) and 10 C.F.R. Part 51, Subpart A, Appendix B to the extent the Board interprets those regulations to preclude Intervenors from submitting new contentions challenging the analysis in the DSEIS regarding two issue: (1) groundwater quality degradation (plants with

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[28] DSEIS at 4-21.

[29] As stated *supra* at Section III.a, Intervenors contend that a waiver is not necessary to raise these issues.

[30] DSEIS at 3-58 to 3-59.

cooling ponds in salt marshes) and (2) water quality impacts on adjacent water bodies (plants with cooling ponds in salt marshes).

Respectfully submitted,

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June 24, 2019

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	
FLORIDA POWER & LIGHT COMPANY	)	Docket No. 50-250-SLR
	)	Docket No. 50-251-SLR
(Turkey Point Nuclear Generating Station, Unit Nos. 3 and 4)	)	
	)	June 24, 2019
(Subsequent License Renewal Application)	)	

CERTIFICATE OF SERVICE

Pursuant to 10 C.F.R. § 2.305, I certify that, on this date, a copy of the foregoing "*Natural Resources Defense Council's, Friends of the Earth's, and Miami Waterkeeper's Petition for Waiver of 10 C.F.R. §§ 51.53(c)(3) and 51.71(d) and 10 C.F.R. Part 51, Subpart A, Appendix B*" was served upon the Electronic Information Exchange ("EIE," the NRC's E-Filing System), in the above-captioned docket, which to the best of my knowledge resulted in transmittal of same to those on the EIE Service List for the captioned proceeding.

/Signed (electronically) by/
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Counsel for Friends of the Earth
June 24, 2019

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY & LICENSING BOARD

In the Matter of	)	Docket Nos. 50-250 & 50-251
FLORIDA POWER & LIGHT COMPANY	)	ASLBP No. 18-957-01-SLR-DB01
(Turkey Point Nuclear Generating Station, Unit Nos. 3 and 4)	)	June 28, 2019
(Subsequent License Renewal Application)	)	

DECLARATION OF E.J. WEXLER IN SUPPORT OF
THE FRIENDS OF THE EARTH, NATURAL RESOURCES DEFENSE COUNCIL &
MIAMI WATERKEEPER

I, E.J. Wexler, P.Eng. (Ontario), being competent to provide this Declaration, declare as follows:

1. I am a hydrogeologist with over expertise in groundwater modeling. I hold a Masters' Degree in Civil Engineering, a M.S. in Earth Sciences, and a B.E. in Civil Engineering. Since 2002, I have been Director of Modeling Services for Earthfx, Inc., where I lead a team of surface water and groundwater modelers. A copy of my curriculum vitae is attached as Attachment A.
2. I have been retained to offer expert opinions on behalf of Intervenors in this proceeding. I am offering an updated version of my June 24, 2019 report in this matter to remove information that may be subject to copyright.
3. The facts in my Expert Report are true and correct to the best of my knowledge, and the opinions expressed in my Expert Report are based on my best professional judgment.

I declare under penalty of perjury under the laws of the United States that the foregoing is true to the best of my knowledge.

Eliezer J. Wexler

Executive Summary

Evaporation from the Florida Power and Light (FPL) Cooling Canal System (CCS) has increased the salinity of the CCS water to values as high as 90 practical salinity units (PSU) or almost three times that of seawater. This hypersaline water has seeped out through the unlined canals, entered the underlying Biscayne Aquifer, and due to its higher density, the hypersaline water has moved to depth in the aquifer and formed a large body of hypersaline groundwater. Field studies have confirmed that high salinity groundwater has migrated westward of the CCS. Results of recent groundwater modeling analyses by Tetra Tech (2018) have also confirmed that migration of saline water from the CCS over a 45 year period was the prime contributor to the presence of a large body of hypersaline groundwater and observed changes in the location of the freshwater/saltwater (FW/SW) interface.

Under a 2016 consent order between FPL and the Florida Department of Environmental Protection (FDEP), FPL is required to maintain the average annual salinity of the CCS at or below 34 PSU, halt the westward migration of hypersaline water from the CCS, and reduce the westward extent of the hypersaline plume to the L-31E Canal within 10 years. A recovery well system consisting of 10 deep groundwater extraction wells has been installed along the western edge of the CCS with the intent of retracting the hypersaline water. The draft supplemental environmental impact statement (SEIS) has accepted analyses by Tetra Tech (2016a) that the recovery system will achieve this objective.

It was noted that the Tetra Tech analyses assumed that the CCS would be maintained at 34 PSU for the duration of the recovery period. New water quality information shows that FPL was unable to achieve freshening (i.e., reducing average salinity) within the CCS despite the addition of an average of 12.8 million gallons per day (MGD) of brackish water from the Upper Floridan Aquifer to the CCS from November 2016 to May 2017, salinities in the CCS did not go down to 35 PSU (FPL 2017a); rather, average salinity concentrations in the CCS were 64.9 PSU in May 2017 (FPL 2017b). My analysis using the Tetra Tech model shows that without freshening the CCS, the recovery system will not be able to meet the target of retracting the hypersaline water. My analysis also points out other limitations in the Tetra Tech analyses and the reliability of the model predictions. We also present results from a new, independently developed model that examines processes within the CCS and indicates that freshening of the CCS will be difficult to achieve with the volumes of water currently being used and the locations selected for adding the water.

My opinions are based on data regarding the hydrogeology, hydrology, and water quality of both surface water and groundwater in the South Dade area available to me as of May 2019, and on my prior numerical modeling studies conducted by myself in the vicinity of the CCS and on reviews of modeling work prepared by Tetra Tech on behalf of FPL.

Background:

Cooling Canal System and Hypersaline Plume

The Florida Power and Light (FPL) Cooling Canal System (CCS) is a “closed loop” system that originally contained seawater from Biscayne Bay. The canals are not lined and the system interacts with the underlying groundwater. Inputs into the canals include treated process water, rainfall, stormwater runoff, and groundwater infiltration. Losses include evaporation and seepage from the canals. Over time, evaporation has increased the salinity of the CCS water to values as high as 90 practical salinity units (PSU) or almost three times that of seawater. During the same period, this water entered the underlying Biscayne Aquifer. Due to its higher density, the hypersaline water has moved to depth in the aquifer and formed a body of water with elevated concentrations that has migrated westward of the CCS. The extent of the hypersaline water in the Biscayne Aquifer has been confirmed by water quality samples from monitoring wells and electromagnetic mapping (EM) surveys (e.g., FPL, 2018, Appendix G).

A consent order (Florida Department of Environmental Protection, 2016) between FPL and the FDEP requires FPL to add water from alternative sources to maintain the average annual salinity of the CCS at or below 34 PSU, halt the westward migration of hypersaline water from the CCS, and reduce the westward extent of the hypersaline plume to the L-31E Canal within 10 years. FPL constructed five wells to extract up to 15 MGD of brackish water (2.5 PSU) from the Floridan Aquifer with the bulk of the water used to freshen the CCS (i.e. reduce average CCS salinity). A groundwater recovery well system consisting of 10 deep extraction wells, located along the western edge of the CCS, was constructed and went into operation in May 2018. The wells extract water near the base of the Biscayne Aquifer at a permitted rate of 14 MGD. The water is disposed of through a deep injection well.

Modeling the Extent of the Hypersaline Plume

A key aspect of the draft supplemental environmental impact statement (SEIS), from a groundwater perspective, is the discussion of the results of groundwater modeling studies conducted related to (1) assessing the historic impacts of the CCS on the water quality in the Biscayne Aquifer and (2) the likely effectiveness of proposed recovery wells in retracting the zone of hypersaline water back to the CCS and retracting the freshwater/saltwater (FW/SW) interface back from its current position.

With respect to historic impacts, the draft SEIS cites Hughes et al. (2010), who evaluated the combined effects of salinity and temperature and other variables associated with operation of the CCS and demonstrated that hypersaline water would move downward beneath the CCS to the bottom of the of the Biscayne Aquifer in a period ranging from days to several years. The modeling also indicated that the inland migration of the FW/SW interface, to the west of the CCS, was closely related to high total dissolved solids (TDS) levels. The Hughes et al. (2010) model was mainly intended to demonstrate the likely fate of hypersaline discharge from the CCS and did not attempt to relate the movement to any other factors affecting the FW/SW interface in the area. Tetra-Tech adopted the Hughes et al. (2010) model and used it in early analyses (prior to 2016) of hypersaline water from the CCS.

I independently developed and calibrated a three-dimensional density-dependent groundwater flow/solute transport model for the area surrounding a rock quarry close to the FPL site. A significant effort was directed to recreating the hydrologic history of the South Dade area starting in 1945 to the present and on representing the migration of the FW/SW interface over time. There was also an effort made to incorporate measured values of aquifer properties based on U.S. Geological Survey (USGS) studies (e.g. Fish and Stewart, 1991 and Merritt, 1997). While the primary focus of the modeling effort was to examine the impact of the quarry development on the position of the FW/SW interface, simulations showed that since its inception, the CCS was the key influence on the migration of the freshwater/saltwater in the Model Lands area. As salinities in the CCS have increased over time, there was a corresponding westward migration of the FW/SW toward the quarry. This more detailed work confirmed the results of the Hughes et al. (2010) simulations and was later shown to be in good agreement with field data from wells and EM surveys.

The Tetra Tech (2016a) model closely followed the implementation of my earlier work but differed in critical areas that limit its effectiveness as a predictive tool especially in the western part of their model. I conducted a critical review of the Tetra Tech (2016a) model. In particular, it was noted that the Tetra Tech (2016a) model did not honor observed regional values but applied local values from on-site testing uniformly across the South Dade area. Changes were made to improve the model calibration as documented in subsequent reports (Tetra Tech, 2016b, 2017c) but these are not cited in the draft SEIS and still did not did not honor observed regional values. Updates to the recovery well analysis made using the revised models were not conducted or have not been presented. We have focussed our analysis on the adequacy of the model and the reliability of the model in light of new information on water quality in the study area.

Finally, Tetra-Tech updated the model for a 2018 "attribution analysis". Additional changes were made with significant modifications to the hydraulic conductivity values used in the model. Model results demonstrated that the CCS was the prime contributor to changes in the location of the FW/SW interface, confirming my earlier results. Updated analyses of the effectiveness of the recovery wells based on the Tetra Tech (2018) model were not conducted or have not been presented.

Analysis of Recovery Wells in Light of New Evidence.

A common point in the modeling analyses discussed above, especially the new 2018 attribution analysis, is that the extent of the hypersaline plume is the result of about 45 years of seepage from a very large contributing body (the CCS). For remediation efforts to be successful, they should be based on a similar spatial scale and time frame. Retracting the hypersaline plume in a highly permeable aquifer with a limited number of wells in a 10 year period will be a considerable challenge. The draft SEIS, however, simply accepts the FPL statement that "that operation of its recovery well system will achieve retraction of the plume back to the FPL site (i.e., Turkey Point site) boundary within 10 years, as required by the 2016 consent order with FDEP". This conclusion was based on the Tetra Tech (2016a) modeling of a recovery system with 10 deep wells spaced about 4000 ft apart along L-31 west of the site. The modeling results for the recovery well system predicted retraction of the westward plume to the edge of the CCS by about 5 years and complete retraction within 10 years, with minor aquifer drawdown impacts.

The Tetra Tech (2016a) modeling has some serious flaws that are especially critical in light of new water quality information showing that FPL was unable to achieve freshening of the CCS even with the addition 10 to 15 MGD of brackish water from the Floridan aquifer. [Specifically, new water quality information shows that FPL was unable to achieve freshening of the CCS even with the addition of an average of 12.8 MGD of Upper Floridan aquifer brackish water to the CCS from November 2016 to May 2017, salinities in the CCS did not go down to 35 PSU (FPL 2017a), at the end of May 2017, average salinity concentrations in the 25 CCS were 64.9 PSU (FPL 2017b)]. Most significantly, the Tetra Tech (2016a) simulations of the recovery wells included the assumption that TDS in the CCS would be brought down to 35 PSU at the outset of recovery well operations.

To test the effect of not being able to achieve the 35 PSU target, I first conducted separate simulations with and without the remedial pumping using the Tetra Tech (2017) model (the most recent model files for Alternative 3D provided by FPL for review). The results indicated that much of the change in the area west of the CCS was due to freshening of the CCS rather than the pumping.

Additional simulations with the FPL model and no freshening of the CCS (i.e. the CCS remains at 60 PSU) resulted in hypersaline water continuing to move west of the CCS. Results showing the simulated relative chloride levels in Layer 8 (the "Lower High Flow zone" in the Tetra Tech (2016a) model) for the baseline conditions (pumping and freshening) are shown in Figure 1. The 1.0 relative salinity contour represents seawater salinity and is mostly near the CCS boundary. Results without freshening are shown in Figure 2 and show the 1.0 contour as much as 12,000 ft west of the CCS. These results indicate that, without being able to achieve freshening at the current time or in the future, the retraction of the hypersaline water is not likely to occur without the addition of more wells and increased pumped volumes. More analysis would be required to determine whether the additional withdrawals would have harmful effects and the additional water may, therefore, be unavailable. Thus despite the considerable lead time cited in the draft SEIS, groundwater remediation and improvement may not be possible prior to the subsequent period of extended operations without significant changes to the CCS operations and recovery well system.

It should be also be noted that the FPL models (Tetra Tech, 2016a, 2016b, and 2017) showed that pumping would not pull the hypersaline plume back in the deeper layers (e.g., model Layer 10 near the aquifer base) within the 10 year period despite that pump screens being located in the deep layers. Figure 3 shows the simulated concentrations in the Layer 10 after 10 years of pumping and freshening. The concentrations within and west of the CCS remain above sea water concentrations. These results indicate again that meeting the 2016 consent order with FDEP is not achievable with the number of wells and pumping volumes proposed.

As was noted above, the Tetra Tech (2017) model was changed significantly for the 2018 attribution assessment but the recovery wells analysis was not updated or reported. If this model represents an improved understanding of the area, there is a need to verify that the proposed recovery system can meet its design objectives.

In particular, the horizontal hydraulic conductivity values have been changed from the previous (2017 update) model, with the newer values being generally higher. The spatial distribution of the high and low hydraulic conductivity values within Layer 8 (the most permeable layer) has been altered significantly. The zone of high hydraulic conductivity in the southwest part of the CCS (centered between TPGW-2 and TPGW-17) (shown in Figure 4) has been removed and relatively low values are assigned below the CCS and to the west in the 2018 model (Figure 5). This results in reduced westward migration of hypersaline water in the 2018 analyses. Layer 8 contributes the most to the transmissivity of the Fort Thompson Formation (the high permeability unit forming the principal part of the Biscayne Aquifer) and significant changes in transmissivity of this unit can be seen. Figure 6 shows the transmissivity of the Fort Thompson Formation (model Layers 3 to 11) in the Tetra Tech (2017) model (Figure 7), in thousands of ft^2/d with a zone of high transmissivity within the southwestern part of the CCS. Figure 8 shows the transmissivity of the Fort Thompson Formation with the high transmissivity zone absent. Transmissivities west of Card Sound Road are generally higher in the 2018 model but still well below the observed values (e.g., Fish and Stewart, 1991 or Hughes and White, 2014).

The spatial distributions of hydraulic conductivity in the 2017 and 2018 Tetra Tech models are based on the use of the pilot point technique for automated parameter estimation, a technically advanced and accepted method. It should be recognized that the method can easily accommodate known values in the interpolation of hydraulic conductivities, such as data from Fish and Stewart and other sources, but this was not done by Tetra Tech. As well, the number of pilot points used (16) is extremely small for a study area of this size and with the known high degree of spatial heterogeneity. This partly explains the large shifts in property values between model versions. These deficiencies need to be examined further as they can compromise the effectiveness of the model to be used in the analysis of recovery wells.

The earlier model (Tetra Tech, 2016a) did not simulate ET processes directly. Instead, a net recharge was calculated as the recharge rate minus ET. However, recharge rates were set to zero when ET exceeded recharge (Tetra Tech, 2016a). This negated the effect of groundwater ET processes that, at times, reversed the natural eastward flow in the Model Lands area and facilitated the westward movement of hypersaline water from the CCS. The 2018 model now simulates groundwater ET when ET exceeds recharge. The analysis of recovery well performance should be updated to see if the retraction of the plume can still be achieved in light of the increased ET rates.

Recharge and evaporation rates were set to zero over the CCS in the Tetra Tech (2016a) model and these processes are not simulated. Instead, the water levels and concentrations in the CCS were specified as boundary conditions based on external water budget model calculations, a process that can lead to inconsistencies. As well, because of the large size of the CCS, the linear geometry of the berms and canals, and the placement of flow restriction measures, mixing of water in the CCS may not be uniform, as is assumed in the Tetra Tech model.

As part of this review, I developed a more refined model of the study area that attempted to better represent flow in the CCS and the effect of evaporation and adding water to the CCS. Key features of the model are described in a draft report (Earthfx, 2019). Simulations of future conditions were conducted with flow in the CCS, evaporation, and the introduction of 10 MGD of Floridan water and 14 MGD from the recovery wells. The recirculation of water option was used in SEAWAT to estimate the concentrations of the recovery well water and to represent the recirculation of water through the plant. Concentrations vary over time from the starting conditions (about 1.71 relative salinity (60 PSU)) and reach a relative equilibrium by 2028. Simulated concentrations are shown in Figure 8 and indicate that placement of the Floridan and recovery water along the west side of the CCS has helped in preventing movement of the hypersaline water over most of the western boundary of the CCS but the bulk of the CCS is still hypersaline and a breakout zone occurs in the northeast corner due to the higher water levels in that area.

While the Earthfx (2019) model differs from the Tetra Tech (2016a) model, the results indicate that more analysis is required to understand the dynamics of CCS and the effects of where freshening water is applied. The current spreadsheet water balance model used is in the FPL environmental report is not adequate for this analysis.

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Figures

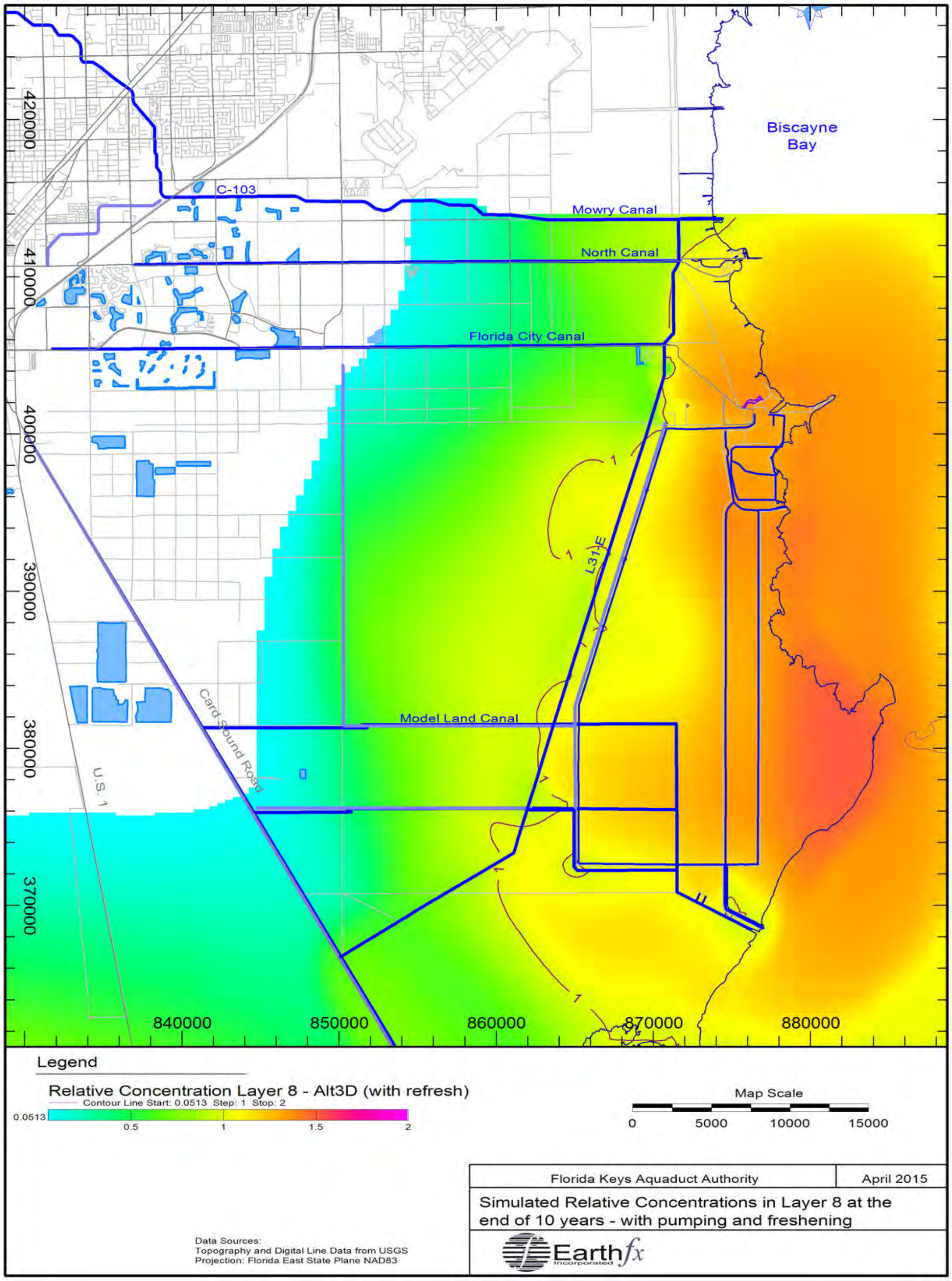

Figure 1: Simulated relative salinity values (with 1.0 equivalent to seawater) in Tetra Tech (2017) model Layer 8 (the "Lower High Flow zone") after 10 years of pumping the recovery wells and with freshening of the CCS to 35 PSU (relative salinity of 1). Note that the 1.0 contour has generally drawn close to the CCS boundary, that the relative salinity beneath the CCS is still above 1.0, and that there is a zone of higher salinity outside the northwest corner of the CCS.

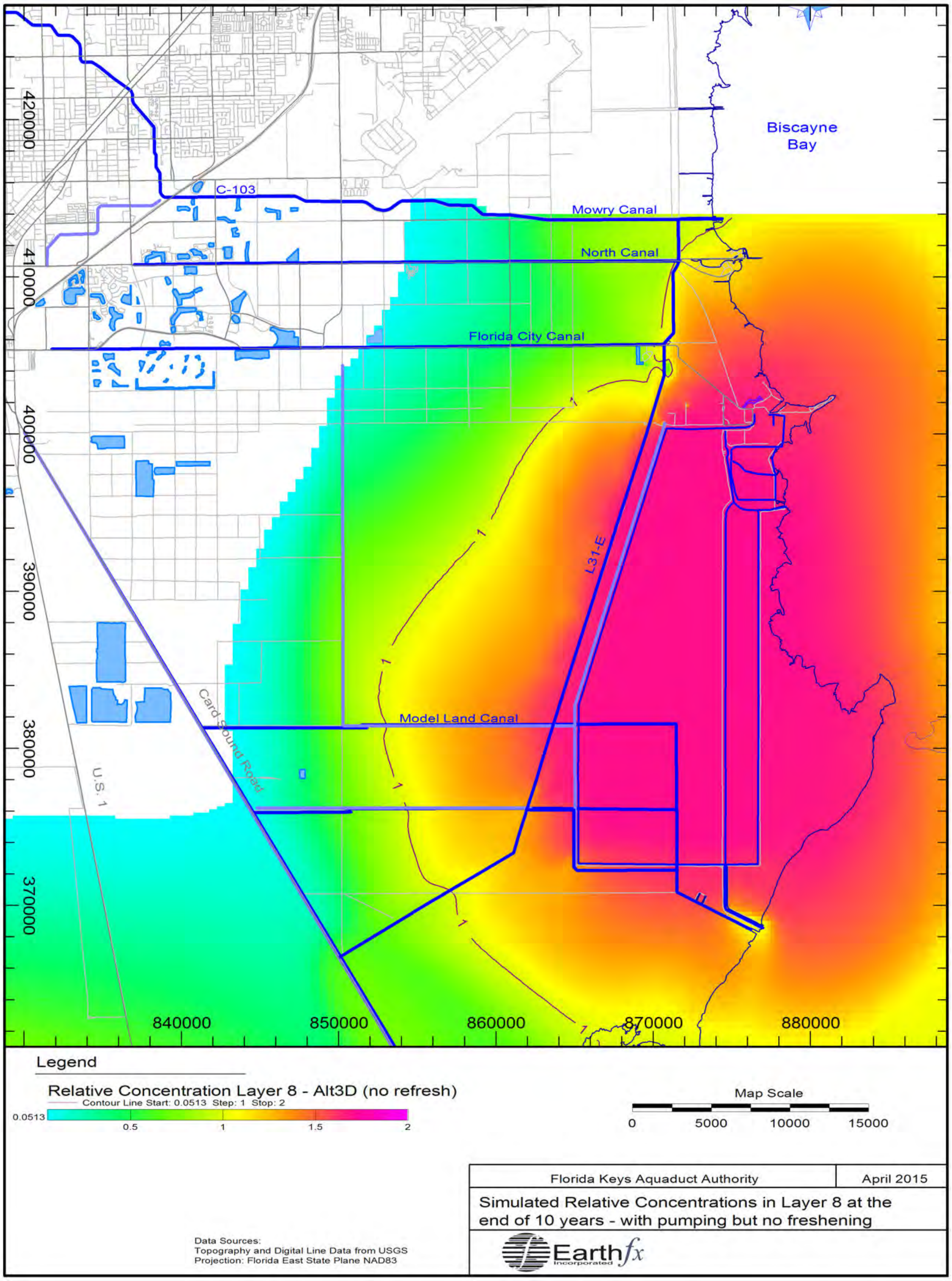

Figure 2: Simulated relative salinity values (with 1.0 equivalent to seawater) in Tetra Tech (2017) model Layer 8 (the "Lower High Flow zone") after 10 years of pumping the recovery wells and with the CCS at 60 PSU (relative salinity of 1.71). Note that the 1.0 contour is up to 12,000 ft west of the CCS boundary.

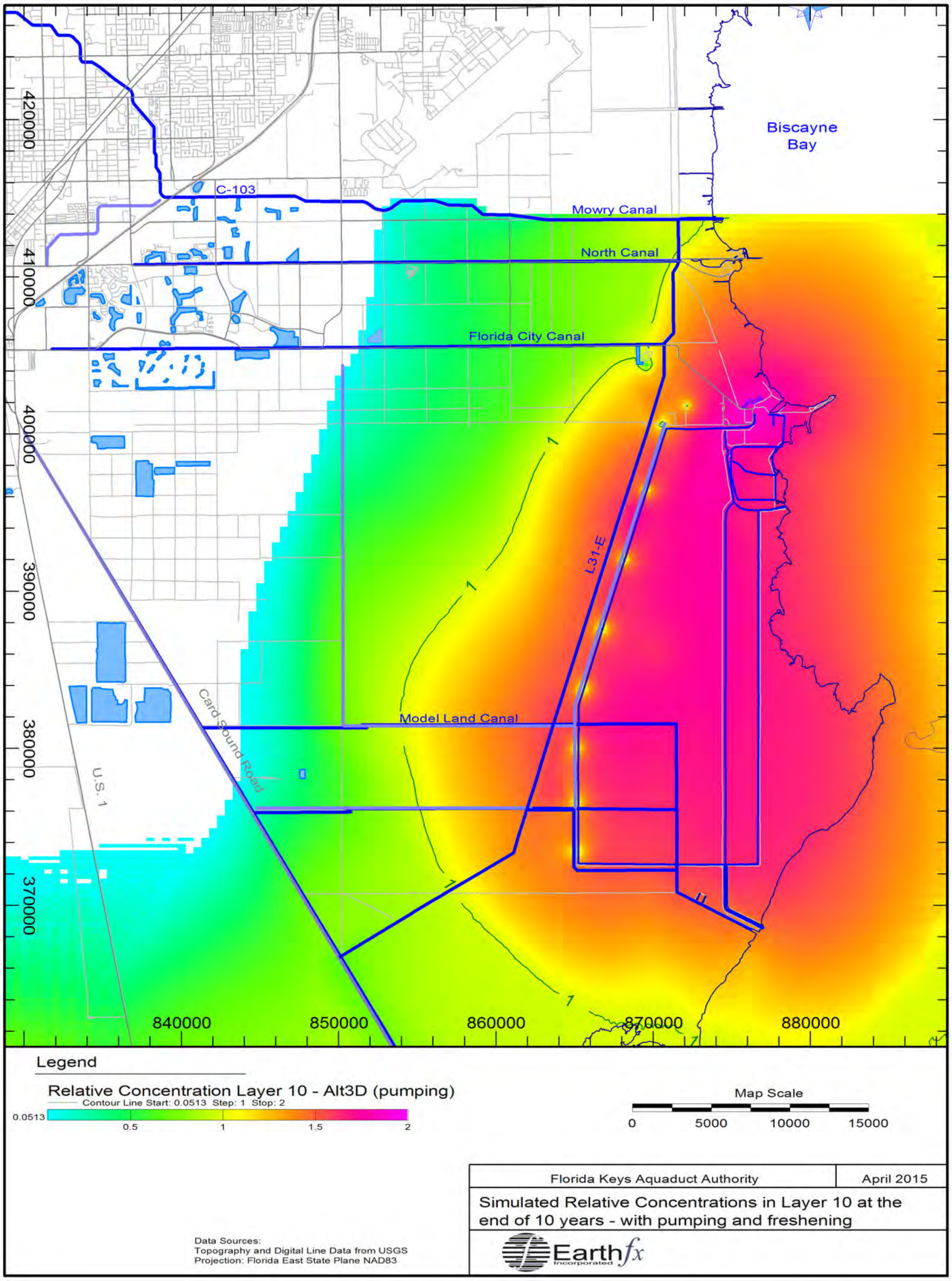

Figure 3: Simulated relative salinity values (with 1.0 equivalent to seawater) in Tetra Tech (2017) model Layer 10 (near the base of the Biscayne Aquifer) after 10 years of pumping the recovery wells and with the CCS at 35 PSU (relative salinity of 1.0). Note that the 1.0 contour is located over 10,500 ft west of the CCS boundary and that the relative salinity beneath the CCS is still above 60 PSU (relative salinity of 1.7).

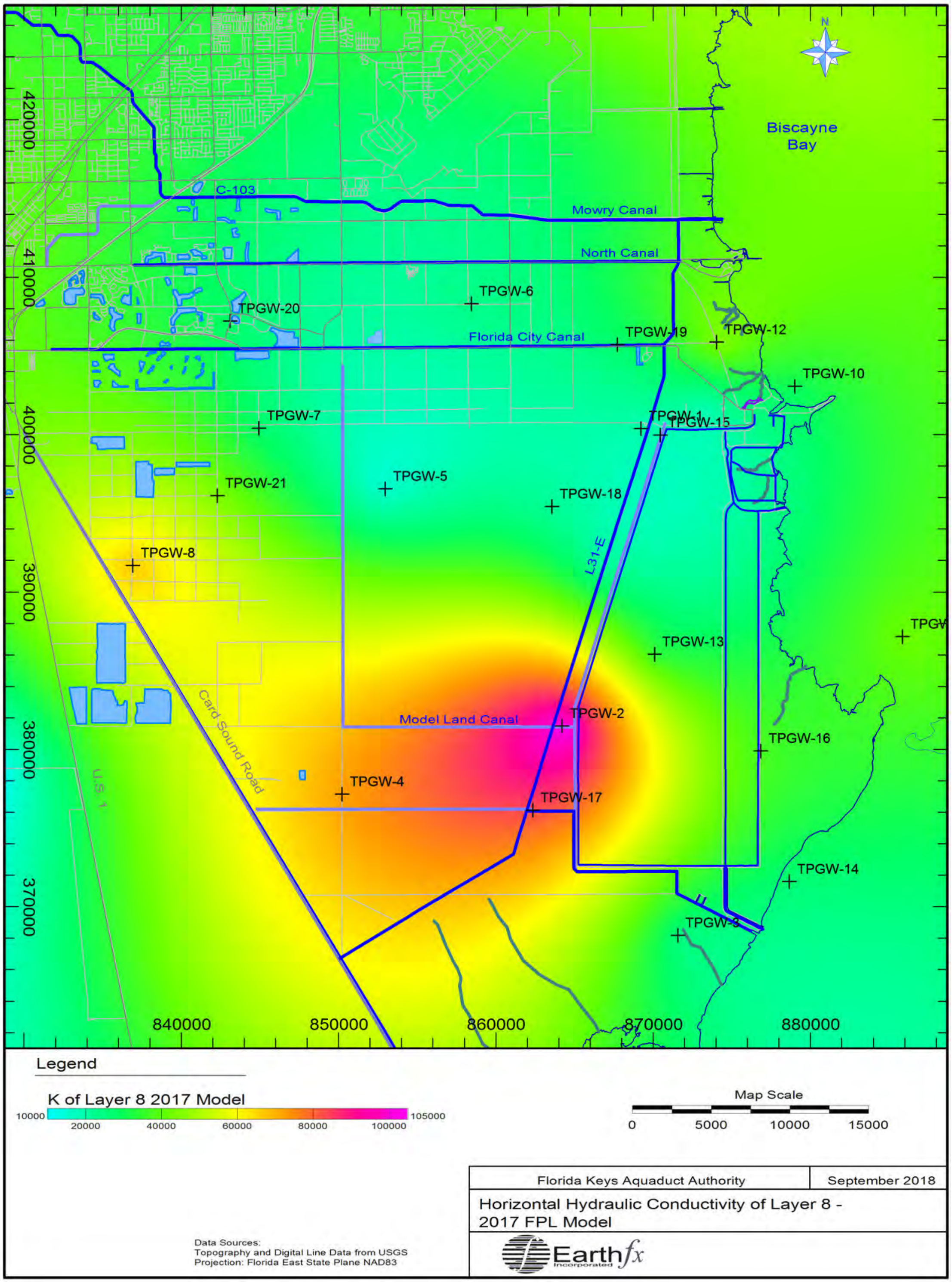

Figure 4: Hydraulic conductivity values assumed for Layer 8 (Lower High Flow Zone) in the Tetra Tech (2017) model.

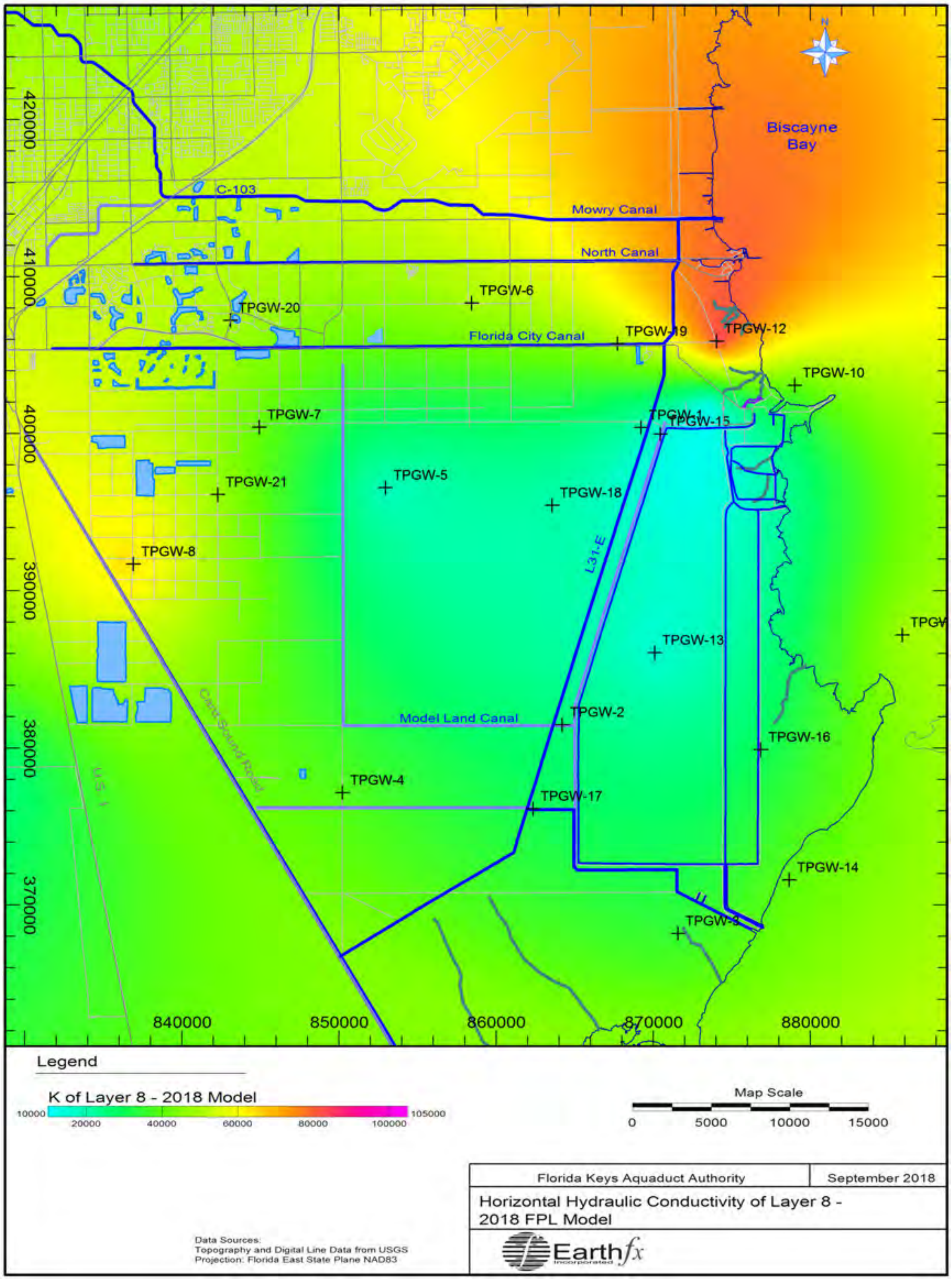

Figure 5: Hydraulic conductivity values assumed for Layer 8 (Lower High Flow Zone) in the Tetra Tech (2018) model.

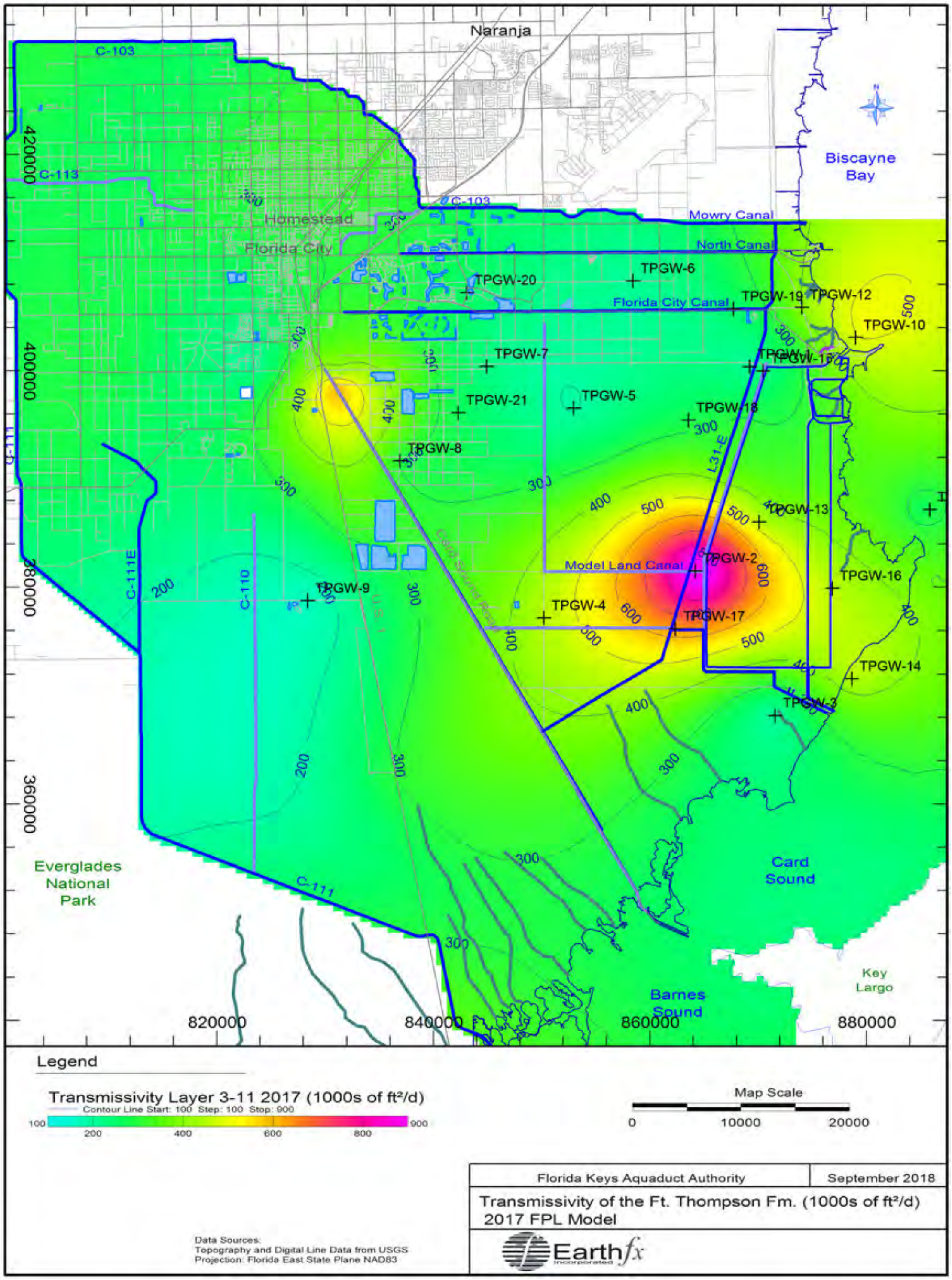

Figure 6: Calculated transmissivities for the Ft. Thompson Formation using the hydraulic conductivity values assumed for Layers 3 to 11 in the Tetra Tech (2017) model.

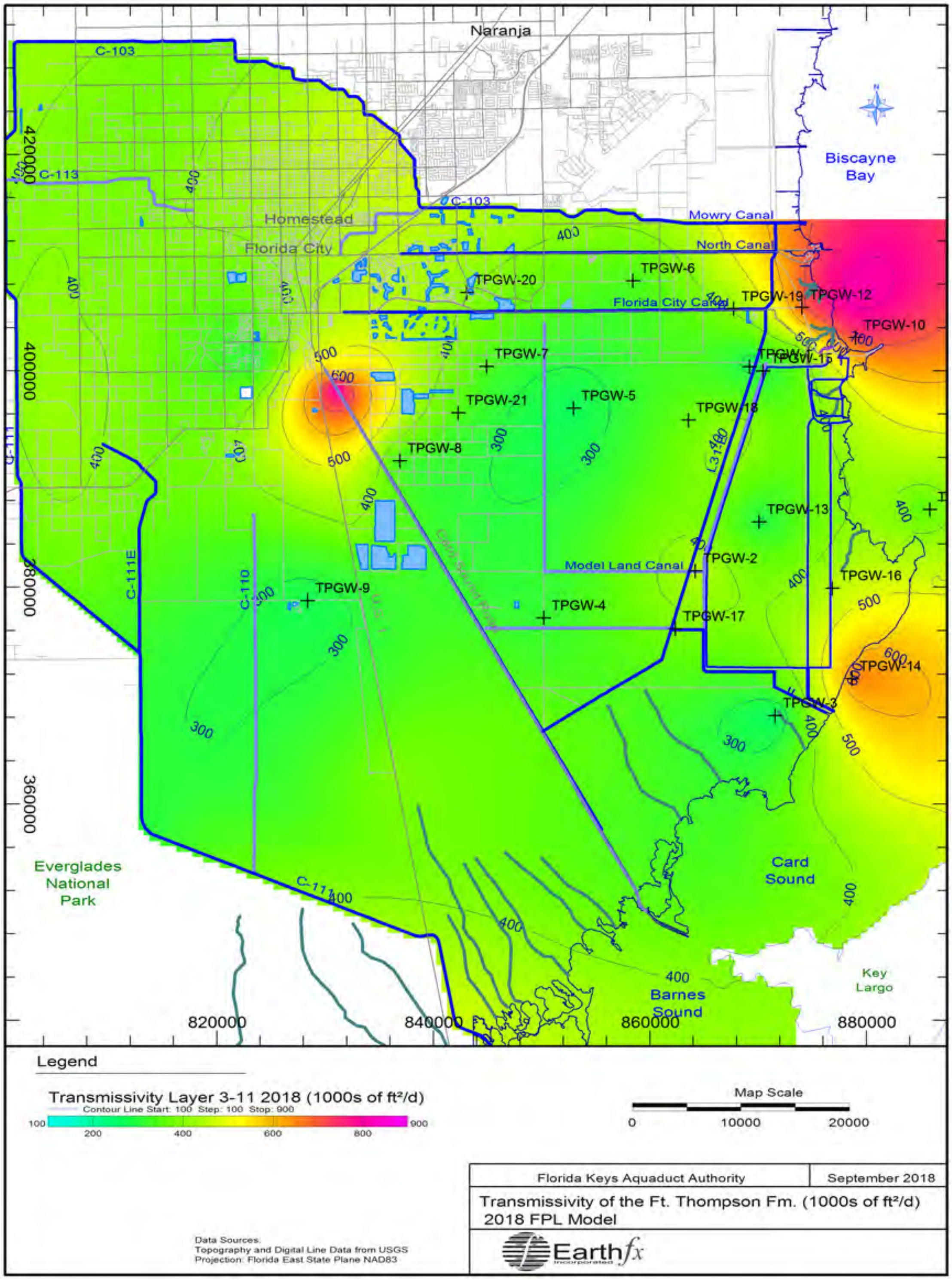

Figure 7: Calculated transmissivities for the Ft. Thompson Formation using the hydraulic conductivity values assumed for Layers 3 to 11 in the Tetra Tech (2018) model.

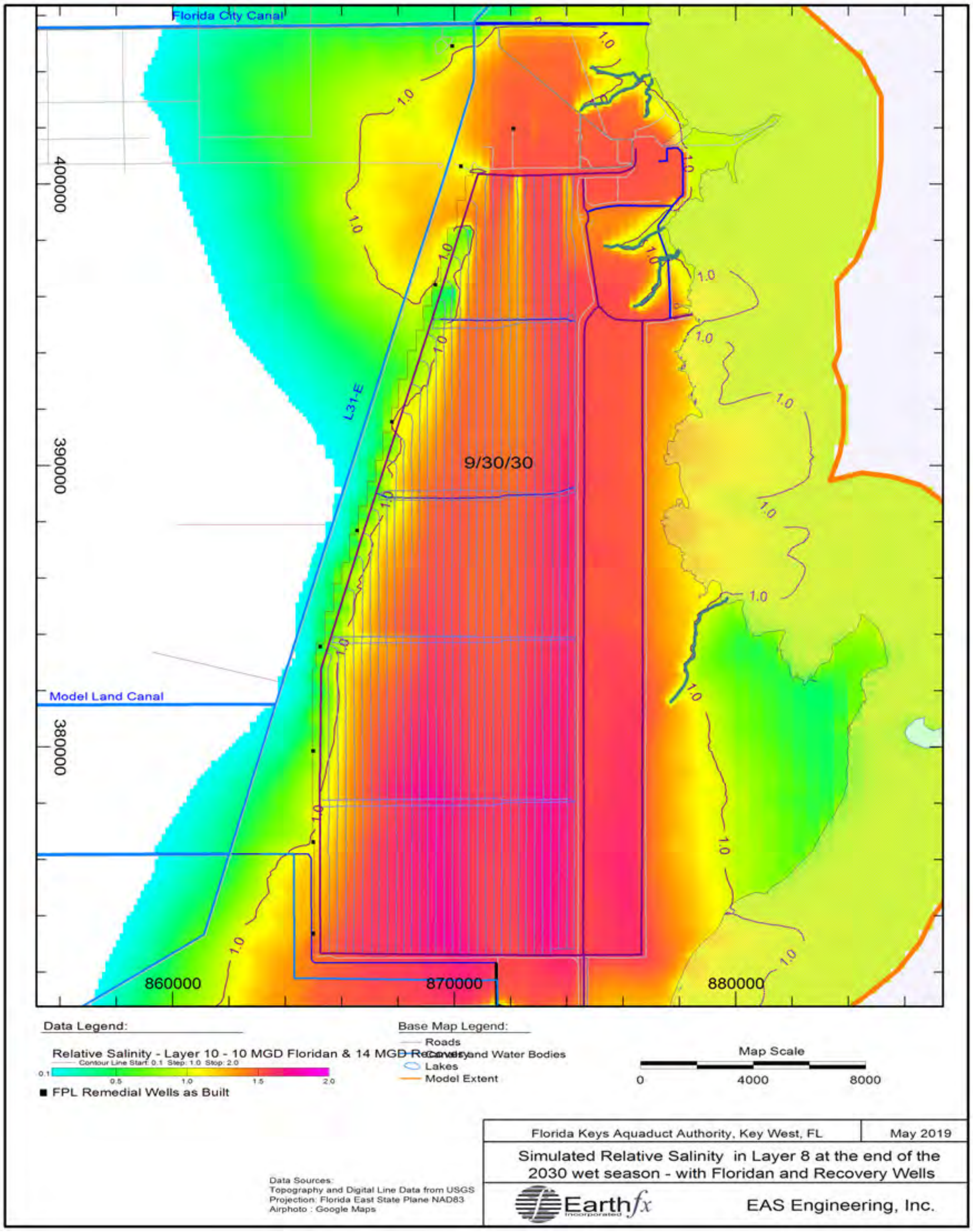

Figure 8: Simulated relative salinity values in the new Earthfx model in Layer 8 (between -30 to -35 NGVD, roughly equivalent to Layers 5/6 in the Tetra Tech models) at the end of the 2030 wet season. Note that relative salinity is greater than 1.0 (> 35 PSU) over most of the CCS. Areas of low salinity occur along the west boundary due to the effects of adding Floridan Aquifer water and due to pumping of the recovery wells. Small plumes of lower salinity occur in the northern part of the CCS due to the addition of Floridan water at these locations.

E. J. Wexler, M.Sc., M.S.E., P.Eng.

Vice-President and Director of Modeling Services

BIOGRAPHY

E.J. Wexler is Vice-President and Director of Modeling Services at Earth*fx* and has over 35 years of experience in groundwater modeling, contaminant hydrogeology, geostatistical analysis, and model code development. He has taught graduate courses in groundwater at universities in Canada, FL, and NY. He worked as a research hydrologist and groundwater modeling specialist for the USGS in Reston, VA, Long Island, NY, and Miami, FL. Mr. Wexler is a licensed engineer in the Province of Ontario, Canada.

EDUCATION

- B.E. Civil Engineering, City University of New York (1977)
- M.S.E. Civil Engineering, Princeton University (1978)
- M.Sc. Earth Science, University of Waterloo (1988)

PROFESSIONAL EXPERIENCE

Director of Modeling Services, Earthfx Inc. ***2002 - Present***

Mr. Wexler is the Director of Modeling Services at Earth*fx* where he leads a team of surface and groundwater modelers. Mr. Wexler's experience at Earth*fx* includes:

- Directing groundwater flow and contaminant transport studies, with an emphasis on integrated groundwater/surface water modeling using GSFLOW.
- Technical Manager for Source Water Protection studies in southern Ontario. This included regional groundwater flow modeling studies for aquifer and wellhead vulnerability assessment and hydrologic modeling for water quality and water quantity risk assessment.
- Technical Manager for Lake Simcoe Protection Plan studies in southern Ontario. These subwatershed studies assessed regional groundwater flow, delineated ecologically significant groundwater recharge areas, and quantified the impact of land development, drought, and climate change on watershed function.
- Project Manager for an Integrated Catchment Management Plan for in Northern Oman.
- Member of Scientific Peer Review team for evaluating the Tampa Bay Water/SWFWMD North Tampa Bay integrated model.
- Conducted integrated GW/SW modeling study for a large-land development in Ft. Meyers, FL and a study of FW/SW interface movement in the Homestead, FL area.
- Project Manager for hydrogeologic data analyses in South Florida related to the Comprehensive Everglades Restoration Program (CERP)
- Developed geostatistical analysis codes (3-D kriging and variogram analysis) for VIEWLOG and advanced water quality analysis modules for SiteFX.

Hydrogeologist/Hydrologist, Gartner Lee Limited ***1990 - 2002***

As a senior hydrogeologist at Gartner Lee, Mr. Wexler directed groundwater modeling, groundwater resources management and contaminant hydrogeology studies in Canada, Florida and the Middle East. Selected projects where he was principal investigator include:

- Development of a groundwater flow and contaminant transport model for a low-level radioactive waste disposal site and evaluation of remedial measures.
- Development of a groundwater flow model for St. Thomas, U.S. Virgin Islands used to investigate the source of volatile organic compounds affecting water supply wells.
- Development of surface water and groundwater models to assess the impact of artificial recharge on the water balance, groundwater flow patterns and salt water intrusion in the arid coastal regions of Northern Oman.
- Co-development of MODNET, a surface water and groundwater model based on the USGS MODFLOW model and the USACE UNET surface water model for SFWMD.

Research Hydrologist, U.S. Geological Survey, Miami, Florida 1986 - 1990

Mr. Wexler researched and developed models for simulating groundwater/surface water interaction. He also investigated the effects of density-dependent groundwater flow and solute transport on the feasibility of freshwater storage and recovery in saline aquifers (ASR) at Cape Coral, FL. He developed a coupled, regional-scale/fine-scale flow and transport model for simulating leachate migration at landfills in West Palm Beach, FL. He served as the Groundwater Discipline Specialist and Digital Modeling Specialist and was responsible for technical review and quality control for other surface water and groundwater modeling investigations.

Hydrologist, U.S. Geological Survey, Long Island, New York 1981 - 1985

Mr. Wexler was the Project Chief of a groundwater contaminant transport study at a sanitary landfill site. He investigated the local hydrogeology and studied the physical and geochemical controls on the transport of groundwater solutes. He developed flow and transport models for the study area and simulated long-term contaminant migration.

Research Hydrologist, U.S. Geological Survey, Reston Virgina 1979 - 1981

Mr. Wexler was responsible for developing and testing finite-element models for simulating groundwater flow, solute transport and parameter estimation. E.J. consulted on field application of these models to sites in Maine, Kansas, and California.

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LBP-19-06

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:

E. Roy Hawkens, Chairman
Dr. Michael F. Kennedy
Dr. Sue H. Abreu

In the Matter of	Docket Nos. 50-250-SLR & 50-251-SLR
FLORIDA POWER & LIGHT COMPANY	ASLBP No. 18-957-01-SLR-BD01
(Turkey Point Nuclear Generating Units 3 and 4)	July 8, 2019

MEMORANDUM AND ORDER
(Granting FPL's Motions to Dismiss Joint Intervenors'
Contentions 1-E and 5-E as Moot)

In LBP-19-03, this Licensing Board granted a hearing request from Friends of the Earth, Inc., Natural Resources Defense Council, Inc., and Miami Waterkeeper, Inc. (collectively, Joint Intervenors) and admitted two environmental contentions of omission they proffered challenging Florida Power & Light Company's (FPL's) subsequent license renewal application for Turkey Point Nuclear Generating Units 3 and 4. Thereafter, following the NRC Staff's issuance of the Draft Supplemental Environmental Impact Statement (DSEIS), FPL moved to dismiss the two contentions as moot based on new information in the DSEIS. For the reasons discussed below, we conclude that the new information in the DSEIS has cured the omissions identified in the two contentions, and we grant FPL's motions to dismiss.

I. BACKGROUND

This proceeding concerns the subsequent license renewal application submitted by FPL for two nuclear power reactors, Turkey Point Units 3 and 4, near Homestead, Florida.[1] As relevant here, on March 7, 2019, this Licensing Board granted hearing requests from Joint Intervenors and Southern Alliance for Clean Energy (SACE). See LBP-19-3, 89 NRC __, __ (slip op. at 63) (2019). We admitted two contentions of omission proffered by Joint Intervenors — Contentions 1-E and 5-E — alleging that FPL improperly failed to include required information in its Environmental Report (ER). See id. at __ n.82 (slip op. at 63 n.82).[2] We also admitted two environmental contentions proffered by SACE. See id. at __ n.81 (slip op. at 63 n.81).

On April 9, 2019, SACE withdrew from this proceeding as part of a global settlement with FPL. See [SACE's] Notice of Withdrawal (Apr. 9, 2019). In light of SACE's withdrawal, the only remaining contentions in this proceeding are Joint Intervenors' Contentions 1-E and 5-E. Contention 1-E claims that "[i]n light of the adverse impact of continued [cooling canal system (CCS)] operations on the threatened American crocodile and its critical seagrass habitat, the ER is deficient for failing to consider mechanical draft cooling towers as a reasonable alternative to the CCS in connection with the license renewal of Turkey Point Units 3 and 4." LBP-19-3, 89 NRC at __ n.82 (slip op. at 63 n.82). Contention 5-E asserts that "[t]he ER is deficient in its

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[1] See [FPL], Turkey Point Nuclear Plant Units 3 & 4 Subsequent License Renewal Application (rev. 1 Apr. 2018) (ADAMS Accession No. ML18113A146).

[2] "A contention of omission is one that alleges an application suffers from an improper omission, whereas a contention of adequacy raises a specific substantive challenge to how particular information or issues have been discussed in the application." Fla. Power & Light Co. (Turkey Point Nuclear Generating Plant, Units 6 & 7), LBP-11-6, 73 NRC 149, 200 n.53 (2011); accord Pac. Gas & Elec. Co. (Diablo Canyon Nuclear Power Plant, Units 1 & 2), CLI-16-11, 83 NRC 524, 534 (2016) ("Contentions that claim a failure to include an entire subject matter or study might be considered contentions of omission. Contentions that argue for alternative analyses or refinements to [an] analysis might be characterized as contentions of 'adequacy.'") (internal footnote omitted) (citing, e.g., Duke Energy Corp. (McGuire Nuclear Station, Units 1 & 2; Catawba Nuclear Station, Units 1 & 2), CLI-02-28, 56 NRC 373, 382–83 (2002)).

failure to recognize Turkey Point as a source of ammonia in freshwater wetlands surrounding the site, and in its failure to analyze the potential impacts of ammonia releases during the renewal period on threatened and endangered species and their critical habitat." Id.

In March 2019, the NRC Staff issued a DSEIS for Turkey Point Units 3 and 4.[3] Pursuant to the migration tenet,[4] Contentions 1-E and 5-E, which originally challenged FPL's ER, became challenges to the NRC Staff's DSEIS.

On May 20, 2019, FPL moved this Board to dismiss Contentions 1-E and 5-E as moot, arguing that information in the NRC Staff's DSEIS cured the omissions identified in those contentions.[5]

On June 10, 2019, the NRC Staff filed an answer supporting FPL's motions to dismiss both contentions as moot.[6] Joint Intervenors filed answers opposing FPL's motions.[7]

For the reasons discussed below, we grant FPL's motions to dismiss Contentions 1-E and 5-E as moot.

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[3] See Office of Nuclear Reactor Regulation (NRR), NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supp. 5, Second Renewal, Regarding Subsequent License Renewal for Turkey Point Nuclear Generating Unit Nos. 3 & 4, Draft Report for Comment (Mar. 2019) (ADAMS Accession No. ML19078A330) [hereinafter DSEIS].

[4] "[A] contention 'migrates' when a licensing board construes a contention challenging [an ER] as a challenge to a subsequently issued Staff [National Environmental Policy Act] document without the petitioner amending the contention." Crow Butte Res., Inc. (In Situ Leach Facility, Crawford, Neb.), CLI-15-17, 82 NRC 33, 42 n.58 (2015).

[5] See FPL's Motion to Dismiss Joint Petitioners' Contention 1-E as Moot (May 20, 2019) [hereinafter Motion to Dismiss Contention 1-E]; FPL's Motion to Dismiss Joint Petitioners' Contention 5-E as Moot (May 20, 2019) [hereinafter Motion to Dismiss Contention 5-E].

[6] See NRC Staff's Answer to FPL's Motions to Dismiss (June 10, 2019) [hereinafter NRC Staff Answer].

[7] See Joint Petitioners' Answer Opposing FPL's Motion to Dismiss Joint Petitioners' Contention 1-E as Moot (June 10, 2019) [hereinafter Answer Opposing Motion to Dismiss Contention 1-E]; Joint Petitioners' Answer Opposing FPL's Motion to Dismiss Joint Petitioners' Contention 5-E as Moot (June 10, 2019) [hereinafter Answer Opposing Motion to Dismiss Contention 5-E].

II. LEGAL STANDARD

It is undisputed that Contentions 1-E and 5-E are contentions of omission. A contention of omission claiming that an ER fails to include required information can be cured by the applicant supplying the missing information in a revised ER or by the NRC Staff supplying the missing information in an environmental impact statement (EIS). See McGuire/Catawba, CLI-02-28, 56 NRC at 384. When the missing information "is later supplied by the applicant or considered by the Staff in a draft EIS, the contention is moot" and should be dismissed. Id. at 383; accord USEC, Inc. (American Centrifuge Plant), CLI-06-9, 63 NRC 433, 444 (2006).

III. ANALYSIS

A. CONTENTION 1-E HAS BEEN RENDERED MOOT BY THE NRC STAFF'S DSEIS

Pursuant to the migration tenet, see supra note 4, Contention 1-E alleges that the NRC Staff's DSEIS improperly "fail[s] to consider mechanical draft cooling towers as a reasonable alternative to the CCS" in light of "the adverse impact of continued CCS operations on the threatened American crocodile and its critical seagrass habitat." LBP-19-3, 89 NRC at __ n.82 (slip op. at 63 n.82). FPL and the NRC Staff argue that the DSEIS's extensive discussion of mechanical draft cooling towers as an alternative to the CCS renders Contention 1-E moot. See Motion to Dismiss Contention 1-E at 4; NRC Staff Answer at 5–7. We agree.

Section 2.2.3 of the DSEIS considers the use of mechanical draft cooling towers "that might be used to mitigate the potential impacts associated with continued use of the existing [CCS]." DSEIS at 2-12. Under the cooling towers alternative evaluated by the NRC Staff, Turkey Point Units 3 and 4 would each use three closed-cycle, wet-cooling towers to dissipate heat from the reactor cooling water systems. See id. at 2-13. These mechanical draft cooling towers would be octagonal in shape and extend about 70 feet in height and 250 feet in diameter. See id. The primary source of cooling water is assumed to be reclaimed wastewater.

See id. Cooling water makeup would be about 38 million gallons per day, and consumptive water use would be about 29 million gallons per day. See id.

Under the mechanical draft cooling towers alternative, Turkey Point Units 3 and 4 would no longer use the CCS, which, the NRC Staff reasons, would result in (1) less heat being discharged to the CCS, which could cause the water in the CCS to become less saline and, thus, more hospitable for threatened species; and (2) less flow within the CCS, which could cause the water in the CCS to become stagnant and less hospitable for threatened species. See DSEIS at 4-68.[8] FPL would still be required to take the CCS restorative actions mandated by a 2016 Consent Order with the State of Florida[9] and a 2015 Consent Agreement with Miami-Dade County,[10] see id., which compel FPL to, inter alia, decrease the salinity in the CCS, develop a nutrient management plan for the CCS, and restore seagrass within portions of the CCS.[11] The NRC Staff concludes that, under these circumstances, "the CCS would likely continue to provide habitat for [Endangered Species Act]-listed species." Id.

The DSEIS evaluated the environmental consequences of the mechanical draft cooling towers alternative with respect to each resource area that would be affected. See DSEIS

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[8] As the DSEIS explains, even if Units 3 and 4 no longer use the CCS, all liquid discharges from the Turkey Point facility, including storm water, would continue to flow into the CCS. See DSEIS at 4-35. Additionally, Unit 5 — an operating fossil-fueled unit that uses cooling towers, see id. at 3-8 — would continue to discharge cooling tower blowdowns to the CCS. See id. at 4-35. CCS water would continue to be circulated through retired fossil-fueled Units 1 and 2; however, this circulation would not add heat to the CCS. See id. at 3-8, 4-35.

[9] See Fla. Dep't of Envtl. Prot. v. FPL, OGC File No. 16-02441, Consent Order (June 20, 2016) (ADAMS Accession No. ML16216A216) [hereinafter Florida Consent Order].

[10] See Miami-Dade County, Dep't of Regulatory and Econ. Res., Division of Envtl. Res. Mgmt. v. FPL, Consent Agreement (Oct. 7, 2015) (ADAMS Accession No. ML15286A366) [hereinafter Miami-Dade Consent Agreement].

[11] See NRR, Biological Assessment for the Turkey Point Nuclear Generating Unit Nos. 3 and 4 Proposed Subsequent License Renewal at 36 (Dec. 2018) (ADAMS Accession No. ML18353A835) [hereinafter Biological Assessment] (incorporated by reference in the DSEIS at 4-60). The Biological Assessment explains how temperature, salinity, and water quality in the CCS affect American crocodile health, prey species, and habitat. See id. at 32–44.

§ 4.2.7 (impacts on land use and visual resources); id. § 4.3.7 (air quality and noise impacts); id. § 4.4.7 (geologic impact); id. § 4.5.7 (impact on surface water and groundwater resources); id. § 4.6.7 (impact on terrestrial resources); id. § 4.7.7 (impact on aquatic resources); id. § 4.8.3.4 (impact on special status species and habitats); id. § 4.9.4 (historic and cultural resources impacts); id. § 4.10.7 (socioeconomics and transportation impacts); id. § 4.11.7 (human health impact); id. § 4.12.4 (environmental justice impact); id. § 4.13.7 (waste management impact).

Table 2-2 of the DSEIS, in turn, summarizes the impact of the mechanical draft cooling towers alternative on different areas including terrestrial resources, aquatic resources, and special status species and habitats. See DSEIS at 2-22 to 2-23.

Notwithstanding the NRC Staff's encompassing consideration of mechanical draft cooling towers as an alternative to the CCS, the Staff ultimately determined that it "cannot forecast a particular level of impact" by the towers on the American crocodile and its habitat, DSEIS at 2-23, because, according to the NRC Staff, "the magnitude and significance of adverse impacts . . . would depend on the location and layout of the cooling towers, the design of the cooling towers, operational parameters, and the [crocodiles and habitat] present in the area when the alternative is implemented." Id. at 4-70.

Joint Intervenors assert that the above determination in the DSEIS "is not an analysis. It is a failure to analyze. It is an omission. Thus Contention 1-E is not moot and should not be dismissed." Answer Opposing Motion to Dismiss Contention 1-E at 6. We disagree.

We conclude that Contention 1-E's omission is cured because the DSEIS expressly considers mechanical draft cooling towers as an alternative to the CCS, as well as the capacity of cooling towers to reduce adverse impacts on the American crocodile and its habitat. Contrary to Joint Intervenors' assertion, the NRC Staff's professed inability to forecast a particular level of impact on the American crocodile and its habitat cannot fairly be characterized as a wrongful omission given the Staff's explanation that a more precise forecast is not possible because it would depend on factual information that is not currently available. See DSEIS at 4-70.[12] Rather, in our judgment, the alleged deficiency now advanced by Joint Intervenors is in the nature of a claim of adequacy that must be advanced, if at all, as a new contention. See supra note 2; infra note 18 and accompanying text.

Because the DSEIS now considers mechanical draft cooling towers as a reasonable alternative to the CCS in light of the CCS's adverse impact on the American crocodile and its habitat, Contention 1-E is moot.

B. CONTENTION 5-E HAS BEEN RENDERED MOOT BY THE NRC STAFF'S DSEIS

Pursuant to the migration tenet, see supra note 4, Contention 5-E alleges that the NRC Staff's DSEIS improperly fails to (1) "recognize Turkey Point as a source of ammonia in freshwater wetlands surrounding the site"; and (2) "analyze the potential impacts of ammonia releases during the renewal period on threatened and endangered species and their critical habitat." LBP-19-3, 89 NRC at __ n.82 (slip op. at 63 n.82). FPL and the NRC Staff argue that the DSEIS cures both omissions, thereby rendering Contention 5-E moot. See Motion to Dismiss Contention 5-E at 3–6; NRC Staff Answer at 8–12. We agree.

Regarding the first omission, Joint Intervenors do not dispute that it has been cured. The DSEIS explicitly recognizes the existence of ammonia in the CCS caused by the decay of organic material, see DEIS at 3-42,[13] and it acknowledges that ammonia is transported from the CCS by the outflow of water into groundwater that then travels to adjacent surface water bodies. See id. at 3-41, 3-44. This discussion renders the first omission moot.

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[12] The NRC Staff was similarly unable to make a forecast in this resource area for the no-action alternative and the replacement power alternatives. See DSEIS at 2-22, 2-23.

[13] According to the DSEIS, between June 2010 and May 2016, ammonia concentrations in the CCS ranged from below detectable levels to 0.3 milligrams per liter (mg/L), with an average concentration of 0.04 mg/L, which is more than an order of magnitude below the Miami-Dade County water quality standard for ammonia of 0.5 mg/L. See DSEIS at 3-42, 4-22; Biological Assessment at 15.

Joint Intervenors argue, however, that the second omission in Contention 5-E is not moot because the DSEIS allegedly fails to address the potential impacts of ammonia releases on the following threatened and endangered species and their habitat: the Florida panther, American crocodile, indigo snake, snail kite, red knot, and wood stork. See Answer Opposing Motion to Dismiss Contention 5-E at 3. We disagree.

The DSEIS states that, although ammonia concentrations in the CCS are below the Miami-Dade County ammonia water quality standard, see supra note 13, sampling data in 2015 and 2016 revealed concentrations of ammonia exceeding that standard in stagnant water at the bottom of two deep excavations outside of and adjacent to the CCS. See DSEIS at 4-22; see also Biological Assessment at 61 (stating that several other sampling locations in remnant, stagnant canals revealed ammonia concentrations in 2018 above the Miami-Dade County water quality standard).[14] Under the regulatory direction of the State of Florida and Miami-Dade County, FPL is taking steps to eliminate the excess ammonia problem in these stagnant, excavated areas. See DSEIS at 4-23; see also id. at 3-50 to 3-52; Biological Assessment at 60. In light of FPL's restorative actions, the NRC Staff states that "elevated ammonia levels are not expected to be a long-term issue." Biological Assessment at 61.

Moreover, pursuant to the Florida Consent Order and Miami-Dade Consent Agreement, "FPL maintains an extensive water quality monitoring program [in which it] monitors the CCS, Biscayne Bay, Card Sound, and other nearby water bodies for ammonia . . . among other

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[14] The DSEIS states that ammonia concentrations "at the bottom of these excavations may be influenced by groundwater that has been in contact with CCS waters." DSEIS at 3-50. However, according to the DSEIS, the fact that ammonia concentrations in the bottom samples were consistently higher than ammonia levels in the CCS implies that "some of the ammonia in the [excavations] was coming from other sources," including runoff from "agriculture, urban, and wetland land use." Id.; see also FPL, Site Assessment Report, Ammonia in Surface Waters, Turkey Point Facility at 21 (Mar. 17, 2017) ("[T]he observed presence of ammonia [at the bottom of excavations] is consistent with nitrogen cycling of organic matter under [] anoxic [i.e., low oxygen] conditions such as are present at the bottom of a dead-end canal.") (referred to in DSEIS as FPL 2017c and cited, e.g., at 3-51).

nutrients and parameters." Biological Assessment at 60. The NRC Staff states that, "[t]o date, FPL has identified no evidence of an ecological impact on the areas surrounding the CCS and no discernible influence from the CCS on Biscayne Bay." Id. Given the totality of these circumstances, the DSEIS concludes that "the impacts [of ammonia] on adjacent surface water bodies via the groundwater pathway from the CCS during the subsequent license renewal period would be SMALL." DSEIS at 4-23.[15]

Finally, the DSEIS "analyzes the potential impacts of the proposed Turkey Point subsequent license renewal [on the six threatened and endangered species specified by Joint Intervenors]," DSEIS at 4-60, and it summarizes the impacts in Table 4-4. See id. at 4-60 to 4-61. We conclude that NRC Staff analyzed ammonia releases within and around the Turkey Point site and considered the impacts on the listed species and their habitats such that the second omission in Contention 5-E is cured, thereby rendering the contention moot.

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15 Aside from the samples collected from the bottom of the excavated areas and remnant canals showing elevated ammonia levels that FPL is remediating, the NRC Staff found that no other ammonia sample concentration from the CCS or within Biscayne Bay near the CCS exceeded the Miami-Dade surface water standard for ammonia. See DSEIS at 3-51; accord Biological Assessment at 62.

Joint Intervenors nevertheless argue that the NRC Staff's analysis remains deficient because it fails to analyze ammonia impacts on the six listed species or their habitats as specifically as it analyzed ammonia impacts on the West Indian manatee. See Answer Opposing Motion to Dismiss Contention 5-E at 7.[16] Contrary to Joint Intervenors' understanding, this type of argument does not preserve Contention 5-E as a contention of omission; rather, it constitutes a challenge to the adequacy of the Staff's analysis and must be advanced, if at all, as a new contention. See supra note 2; infra note 18 and accompanying text.

IV. CONCLUSION

For the foregoing reasons, we grant FPL's motions and dismiss as moot Contentions 1-E and 5-E.[17]

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[16] While assessing the environmental impacts of ammonia on the West Indian manatee (also a threatened species), the NRC Staff stated that it "assumes that the relevant State water quality criteria are reasonably protective of manatees because under Section 303(c) of the Clean Water Act, the Environmental Protection Agency or the State is required to adopt water quality standards to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Biological Assessment at 60–61. "Therefore, if waters inhabited by manatees meet water quality criteria for ammonia, the NRC staff assumes that there would be no lethal effects or impairment to growth, survival or reproduction to manatee individuals." Id. at 61.

[17] Any mandatory disclosure obligations associated with those contentions are terminated. See 10 C.F.R. § 2.336(d); see also Licensing Board Order (Granting in Part Intervenors' Joint Motion for Partial Reconsideration of Initial Scheduling Order) (Apr. 2, 2019) at 3 n.3 (unpublished) [hereinafter Revised Scheduling Order].

Although our dismissal of Joint Intervenors' contentions disposes of all the admitted contentions in this case, we do not terminate this proceeding at the Licensing Board level for the following reason: in compliance with the governing Scheduling Order, see Revised Scheduling Order at 3, Joint Intervenors have timely proffered new contentions based on the DSEIS, including new contentions alleging that the curative information in the DSEIS has given rise to contentions of adequacy.[18] See [Joint Intervenors'] Motion to Migrate Contentions & Admit New Contentions in Response to NRC Staff's [DSEIS] at 8–17, 21–25 (June 24, 2019). We thus retain jurisdiction of this case, and we shall address Joint Intervenors' motion in a subsequent memorandum and order.

It is so ORDERED.

THE ATOMIC SAFETY
AND LICENSING BOARD

/RA/

E. Roy Hawkens, Chairman
ADMINISTRATIVE JUDGE

/RA/

Dr. Michael F. Kennedy
ADMINISTRATIVE JUDGE

/RA/

Dr. Sue H. Abreu
ADMINISTRATIVE JUDGE

Rockville, Maryland
July 8, 2019

[18] That a contention of omission has been cured and dismissed as moot does not perforce insulate the new curative information from challenge. However, to challenge the adequacy of the new information, an intervenor must timely file a new contention that addresses the factors in 10 C.F.R. § 2.309(f)(1). See McGuire/Catawba, CLI-02-28, 56 NRC at 383.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
FLORIDA POWER & LIGHT COMPANY	)	Docket Nos. 50-250-SLR
	)	50-251-SLR
(Turkey Point Nuclear Generating Units 3 & 4)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing **MEMORANDUM AND ORDER (Granting FPL's Motions to Dismiss Joint Intervenors' Contentions 1-E and 5-E as Moot)** have been served upon the following persons by Electronic Information.

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[Original signed by Clara Sola]
Office of the Secretary of the Commission

Dated at Rockville, Maryland,
this 8th Day of July, 2019

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE COMMISSION

In the Matter of	)	Docket Nos. 50-250 & 50-251
FLORIDA POWER & LIGHT COMPANY	)	ASLBP No. 18-957-01-SLR-DB01
(Turkey Point Nuclear Generating Station, Unit Nos. 3 and 4)	)	August 9, 2019
(Subsequent License Renewal Application)	)	

FRIENDS OF THE EARTH'S, NATURAL RESOURCES DEFENSE COUNCIL'S, AND MIAMI WATERKEEPER'S PETITION FOR REVIEW OF THE ATOMIC SAFETY AND LICENSING BOARD'S RULINGS IN LBP-19-3 AND LBP-19-06

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August 9, 2019

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ARGUMENT

Pursuant to 10 C.F.R. § 2.341, Friends of the Earth, Natural Resources Defense Council, and Miami Waterkeeper (together "Intervenors") seek review of the Atomic Safety and Licensing Board's ("Board") decisions in LBP-19-3[1] and LPB-19-06.[2] Respectfully, the Nuclear Regulatory Commission ("Commission") should reverse these decisions and allow Intervenors to amend their contentions to address deficiencies still remaining in the Draft Supplemental Environmental Impact Statement for the SLRA ("DSEIS").

I. SUMMARY OF DECISION FOR WHICH REVIEW IS SOUGHT

On August 1, 2018, Intervenors submitted a Request for Hearing and Petition to Intervene, which articulated five contentions.[3] These contentions addressed deficiencies in Florida Power & Light Co.'s ("Applicant's") Environmental Report ("ER"),[4] submitted as part of its subsequent license renewal application ("SLRA") for Turkey Point Nuclear Generating Station, Units 3 and 4, in Miami-Dade County, Florida.

On March 7, 2019, the Board issued Opinion LBP-19-3, admitting two of the five contentions in part[5] and determining as a matter of law that 10 C.F.R. § 51.53(c)(3) applies to

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[1] *Fla. Power & Light Co.* (Turkey Point Nuclear Generating Units 3 & 4), LBP-19-3, 89 NRC __, __ (Mar. 7, 2019) (slip op.) (hereinafter "LBP-19-3").
[2] Memorandum and Order (Granting FPL's Motion to Dismiss Joint Intervenors' Contentions 1-E and 5-E as Moot), LPB-19-06 (July 8, 2019) (hereinafter "Dismissal").
[3] Request for Hearing and Petition to Intervene Submitted by [Intervenors], (Aug. 1, 2018) (ML18213A418) (hereinafter "Petition").
[4] Turkey Point Nuclear Power Plant, Units 3 and 4, Applicant's Environmental Report: Subsequent Operating License Renewal Stage (Jan. 2018) (ML18037A836) (hereinafter "ER").
[5] Intervenors did not immediately appeal the denial of their remaining contentions from this Order as, under NRC regulations and precedent, it would be a disfavored interlocutory appeal. *See* 10 C.F.R. § 2.311; *Private Fuel Storage L.L.C.,* (Independent Spent Fuel Storage Installation) CLI-01-1, 53 NRC 1, 5 (Jan. 10, 2001) ("We have

subsequent license renewal proceedings to extend an initial license renewal. While the Board referred its ruling on §51.53(c)(3) to the Commission,[6] 120 days have since passed so the Board's ruling is final.[7]

In March 2019, the NRC Staff published the DSEIS for the SLRA.[8] Pursuant to the migration tenet,[9] Intervenors' admitted contentions challenging the ER became challenges to the DSEIS. On May 20, 2019, Applicant filed two motions to dismiss Intervenors' contentions as moot.[10] On June 10, 2019, Intervenors opposed these motions[11] while the NRC Staff supported them.[12] On July 8, 2019, the Board issued Order LBP-19-06 "disposing of all admitted contentions in the case."[13]

While the Board decided not to "terminate this proceeding at the Licensing Board level" because "Joint Intervenors have timely proffered new contentions based on the DSEIS,"[14] the

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repeatedly held that refusal to admit a contention, where the intervenor's other contentions remain in litigation, does not constitute a pervasive effect on the litigation calling for interlocutory review.").

[6] LBP-19-3, 89 NRC __, __ n.46 (slip op. at 25 n.46) ("Given the significance of this legal issue of first impression, we will refer our ruling on this matter to the Commission pursuant to 10 C.F.R. § 2.323(f)(1).").

[7] *See* 10 C.F.R. § 2.341(a)(2) (providing 120 days for the Commission to review a decision or action by a presiding officer).

[8] NUREG-1437, Supp. 5, Second Renewal, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 5, Second Renewal, Regarding Subsequent License Renewal for Turkey Point Nuclear Generating Unit Nos. 3 and 4, Draft Report for Comment" (Mar. 2019) (ML19078A330) (hereinafter "DSEIS").

[9] *Crow Butte Res., Inc.* (In Situ Leach Facility, Crawford, Neb.), CLI-15-17, 82 NRC 33, 42 n.58 (2015).

[10] FPL's Motion to Dismiss Joint Petitioners' Contention 1-E as Moot (May 20, 2019) (ML19140A355); FPL's Motion to Dismiss Joint Petitioners' Contention 5-E as Moot (May 20, 2019) (ML19140A356).

[11] Joint Petitioners' Answer Opposing FPL's Motion to Dismiss Joint Petitioners' Contention 1-E as Moot (June 10, 2019) (ML19161A360); Joint Petitioners' Answer Opposing FPL's Motion to Dismiss Joint Petitioners' Contention 5-E as Moot (June 10, 2019) (ML19161A361).

[12] NRC Staff's Answer to FPL's Motions to Dismiss (June 10, 2019) (ML19161A252).

[13] Dismissal at 11.

[14] *Id.*

Board's latest decision "disposes of at least a major segment of the case."[15] This decision therefore could be interpreted to be a final agency action. Thus, Intervenors petition for review now in order to preserve all their claims.

II. STANDARD OF REVIEW

"The Commission defers to a Board's rulings on standing and contention admissibility in the absence of clear error or abuse of discretion."[16] While the Commission's review of factual findings is deferential, it will correct findings when there is "strong reason to believe that a board has overlooked or misunderstood important evidence."[17] The Commission reviews legal questions "de novo."[18]

III. DECISIONS AT ISSUE

Intervenors petition the Commission to review the Board's Order LBP-19-3 ruling on a legal question and on a finding that three of Intervenors' filed contentions were inadmissible in their entirety and that two of the contentions were inadmissible in part.

A. The Board Erred by Determining 10 C.F.R. § 51.53(c)(3) Applies to the Preparation of an ER in SLR Proceedings.

The NRC codified its NEPA obligations in 10 C.F.R. Part 51. For "initial" license renewal applications, these regulations divide environmental issues into generic (Category 1) and

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[15] *Nuclear Engineering Company, Inc.* (Sheffield, Illinois Low-Level Radioactive Waste Disposal Site), ALAB-606, 12 NRC 156, 159-160 (1980); *Public Service Co. of New Hampshire* (Seabrook Station, Units 1 & 2), ALAB-894, 27 NRC 632, 635-637 (1988).
[16] *Crow Butte Res., Inc.* (License Renewal for In Situ Leach Facility, Crawford, Nebraska), CLI-09-9, 69 NRC 331, 336 (2009).
[17] *Powertech (USA), Inc.*, CLI-16-20, slip op. at 10–11 (2016).
[18] *Pa'ina Hawaii, LLC* (Materials License Application), CLI-10-18, (slip op. at 20) (2010).

site-specific (Category 2) issues.[19] Section 51.53(c)(3) provides that applicants for "initial" license renewals need not include any site-specific review of Category 1 issues in their ER. Applicant interpreted §51.53(c)(3) to apply to subsequent license renewal proceedings and therefore avoided site-specific review of Category 1 issues throughout its ER. Intervenors argued §51.53(c)(3) does not apply to "subsequent" license renewal proceedings in their Petition to Intervene and subsequent briefings before the Board.[20]

A majority of the Board concluded that §51.53(c)(3) applies to all license renewal proceedings.[21] The Board's decision is erroneous. On its face, §51.53(c)(3) applies only to *initial* license renewals,[22] and therefore, limitations in §51.53(c)(3)(i) on challenging Category 1 issues do not apply to *subsequent* license renewal applications.[23] While the Board's majority disagreed with Intervenors and held that §51.53(c)(3) also applies to *subsequent* license renewals,[24] Judge Abreu concluded in dissent that "the majority's tortuous approach to determining the regulation's applicability wipes away the plain meaning and the original regulatory intent."[25]

In its holding, the majority dismissed "the plain regulatory language" of 51.53(c)(3) as "*not* answer[ing] the question presented, because it neither directs the Commission to apply

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[19] 10 C.F.R. Part 51, Subpart A, Appendix B (listing environmental issues NEPA requires analyzed and assigning them to either Category 1 or 2) for initial licensing reviews.
[20] Petition at 16 n.71, Reply in Support of Request for Hearing and Petition to Intervene Submitted by [Intervenors] (Sep. 10, 2018) (ML18253A280) (hereinafter "Reply") at 4–5; 11–13; [Intervenors] Corrected Response to Applicant's Surreply (filed Oct 1, 2018; corrected Oct. 4, 2018) (ML18277A318).
[21] LBP-19-3, 89 NRC __,__ (slip op. at 9–30_.
[22] Petition at 16 n.71.
[23] Reply at 4.
[24] LBP-19-3, 89 NRC __,__ (slip op. at 25).
[25] *Id.* (slip op. at 15) (Abreu, *dissenting*) (hereinafter "Dissent").

section 51.53(c)(3) to [subsequent license renewal] applicants, nor does it forbid the Commission from doing so."[26] The Board then spent 20 "tortuous" pages explaining why the Commission's intent in drafting §51.53(c)(3) does not mean what it says.

The plain language of §51.53(c) clearly states that subsections (c)(1) and (c)(2) apply generally to "renewal of a license" while subsection (c)(3) applies to applications for "an *initial* renewed license."[27] Both the courts and the NRC apply the principle of statutory construction, "equally applicable to regulatory construction, [] that a text should be construed so that effect is given to all of its provisions, so no part will be inoperative or superfluous, void or insignificant."[28] Subsection (c)(3) is the only paragraph in §51.53 that employs the limiting term "initial" to modify the types of license renewal to which the subsection applies. The Board read that important distinction entirely out of the regulation, drastically altering its scope. The Board also overlooked the fact that §51.53(c)(3) excludes another class of applicants—those that did not "hold[] an operating license . . . as of June 30, 1995." The Board's holding that §51.53(c)(3) applies to *all* subsequent license renewal renders this text superfluous too and effectively amends §51.53(c)(3) as follows:

> For those applicants seeking a~~**n initial**~~ renewed license~~ **and holding an operating license, construction permit, or combined license as of June 30, 1995**~~, the environmental report shall include the information required in paragraph (c)(2) of this section . . .

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[26] LBP-19-3, 89 NRC __,__ (slip op. at 15) (emphasis in original).
[27] 10 C.F.R. § 51.53.
[28] *U.S. Dep't of Energy* (High-Level Waste Repository), LBP-10-22, 72 NRC 661, 671 n.25 (2010) (citing *Silverman v. Eastrich Multiple Investor Fund, LP.,* 51 F.3d 28, 31 (3d Cir. 1995) (original alterations omitted)).

The majority never addressed this textual point.[29] "Of the categories of license renewal applicants, the Commission chose 'initial,' thus implying that this was done to the exclusion of 'subsequent.' Had the Commission meant 'initial and subsequent,' it could have said just that, or 'initial' simply could have been deleted."[30]

In striking "initial" from the regulation, the Board "delve[d] too deeply to find its answer"[31] because, as Judge Abreu said, "looking to current intent while trying to explain away the expressed original intent of the regulations is a bridge too far."[32] The Board's reference to various guidance documents and administrative history is unavailing. While these "may be consulted for background information and the resolution of ambiguities in a regulation's language, its interpretation may not conflict with the plain meaning of the wording used in that regulation."[33]

And even so, a broader review of the regulatory history reveals that the Commission intended to apply §51.53 to initial license renewals only.[34] As Judge Abreu noted, when the Commission proposed this rule, it "anticipated that a licensee might file multiple license renewal

[29] *See also* Dissent at 15–16 ("[I]f the agency can change the meaning of 'initial,' what is to stop it from changing the June 30, 1995, limitation . . . without notice and comment?").
[30] Dissent at 3.
[31] *Id*. at 2.
[32] *Id*. at 14.
[33] *Calvert Cliffs 3 Nuclear Project, LLC, & Unistar Nuclear Operating Servs., LLC* (Calvert Cliffs Nuclear Power Plant, Unit 3), 70 NRC 198, 214 (2009) (citing *Abourezk v. Reagan*, 785 F.2d 1043, 1053 (D.C. Cir. 1986), aff'd, 484 U.S. 1 (1987)); *GUARD v. NRC*, 753 F.2d 1144, 1146 (D.C. Cir. 1985).
[34] Dissent at 4–8.

applications, but nevertheless limited application of the efficiencies to be gained by the Part 51 amendments [to "initial" license renewal applications]."[35] As Judge Abreu further noted:

> The NRC stated that the safety considerations for license renewal application reviews . . . "could be applied to multiple renewals of an operating license for various increments," but in the very next sentence stated that the environmental considerations in the [] amendments would apply on 'to one renewal of the initial license for up to 20 years beyond its expiration.[36]

Thus, "the agency intended the [] amendments for license renewal reviews to apply to one renewal, not multiple renewals."[37]

The Board, moreover, lacks authority to strike any language because it "runs afoul of the APA and set[s] a troubling precedent."[38] An agency cannot *de facto* amend a regulation promulgated through notice and comment rulemaking without again going through notice and comment.[39] Doing so "denies the public an opportunity to comment on a not-insignificant change to the NRC's regulations."[40] No reasonable interpretation of § 51.53(c)(3) can expand the scope of that application to subsequent license renewal applications.

The NRC Staff recently demonstrated site-specific analysis of Category 1 issues is not a wasted effort. In its Draft Supplemental Environmental Impact Statement, the NRC Staff reviewed site-specific impacts from Applicant's cooling canal system ("CCS") and came to

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[35] Dissent at 4.
[36] Dissent at 4 (emphasis in original, original modifications omitted).
[37] Dissent at 4.
[38] Dissent at 15.
[39] *See, e.g., Perez v. Mortg. Bankers Ass'n,* 135 S. Ct. 1199, 1206 (2015) (It is black letter law that the Administrative Procedure Act requires an agency to "use the same procedures when they amend or repeal a rule as they used to issue the rule in the first instance."); *see also* Dissent at 2 (citing same).
[40] Dissent at 14.

conclusions distinct from those in the NRC's Generic EIS. The Staff found that *site-specific* impacts from the hypersaline plume on groundwater resources "at the Turkey Point site are MODERATE for current operations"[41] while the NRC's GEIS found that impacts on "Groundwater quality degradation (plants with cooling ponds in salt marshes) are SMALL."[42]

B. The Board Erred by Denying Contention 1-E with respect to Several Category 2 Issues.

Contention 1-E challenged the ER's failure to consider mechanical draft cooling towers as a reasonable alternative to reduce adverse impacts from the CCS on several Category 2 issues.[43] The Board partially admitted Contention 1-E, but only as a reasonable alternative with respect to impacts on a threatened species and their critical habitat.[44] Thus, an evaluation of a cooling tower alternative would not address impacts from the CCS on two Category 2 issues, groundwater use conflicts and radionuclides released to groundwater.[45] Intervenors raised this issue before the Board.[46]

The Board erred in denying Contention 1-E with respect to CCS impacts on the issues noted above. The Board limited Contention 1-E to impacts on the American Crocodiles and its habitat for the same reasons two reasons it limited Petitioner SACE's Contention 2.[47] First, the Board held that SACE Contention 2 "focuses" on cooling towers as an alternative for "reducing

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[41] DSEIS at 4-27.
[42] 10 C.F.R., Pt 51, Subpt. A, App. B.
[43] Petition at 15–30.
[44] LBP-19-3, 89 NRC __,__ (slip op. at 44).
[45] Petition at 19.
[46] Reply at 21.
[47] LBP-19-3, 89 NRC __,__ (slip op. at 44). The Southern Alliance for Clean Energy ("SACE") submitted separate contentions in this proceeding.

or avoiding adverse environmental effects to *sensitive biota*."[48] Second, the Board held the SACE contention "does not point to any alleged deficiencies in the ER regarding its discussion of environmental impacts of CCS operation" and directs the reader to "see" the Staff's Answer for further information.[49] Neither of these reasons justify limiting the scope Contention 1-E.

On the first point, the Board overlooked the fact that, unlike the SACE contention, Contention 1-E does not "focus" on impacts to "sensitive biota." For example, Contention 1-E states the ER failed to consider cooling towers as an alternative to reduce adverse impacts on groundwater use conflicts.[50] On the second point, the Board erred because the adequacy of the ER's discussion of impacts from the CCS is beyond the scope of Contention 1-E, which if granted only requires a *comparison* of CCS impacts with those of the cooling tower alternative. Applicant can still make this comparison even if Intervenors failed to establish a genuine dispute over the ER's analysis of CCS impacts. Therefore, the Board's decision not to admit these portions of Contention 1-E was in error.

C. The Board Erred in Denying Contention 2-E Regarding the ER's Flawed Analysis of Cumulative Impacts.

Contention 2-E challenged the ER's failure to take a hard look at the cumulative impacts of the continued operation of Units 3 and 4 on surface water and groundwater.[51] Intervenors argued the ER (1) failed to consider the cumulative impacts of sea level rise (increased flooding

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[48] LBP-19-3, 89 NRC __,__ n.58 (slip op. at 41 n.58) (emphasis added).
[49] *Id*.
[50] Petition at 19.
[51] Petition at 30–39.

and storm surge overtopping the cooling canal system and releasing pollutants to surface waters) and increased temperatures (increased salinity in cooling canal system that worsens impacts on water resources); [52] and (2) erroneously assumed cumulative impacts associated with the hypersaline plume emanating from Applicant's CCS will be "small" because of state and county oversight.[53] The Board found that Contention 2-E was inadmissible, concluding that Intervenors had failed to provide adequate support for their assertions and failed to provide sufficient information to raise a genuine dispute of material fact.[54] The Board erred on both accounts.

1. **The Board erred by overlooking evidence presented by Intervenors demonstrating an increased risk that flooding will overtop the CCS during the SLR period and release pollutants to nearby surface waters.**

The Board held that Intervenors only made "conclusory assertions."[55] On overtopping the CSS—which the ER did not address—the Board faulted Intervenors for not discussing "such necessary information as the relationship between their projected sea levels and the relevant elevations of the Turkey Point site, its sea level barriers, or the CCS, to support their claim that the site will be flooded and the CCS will be overtopped . . . ."[56] The Board erred, however, because it "overlooked or misunderstood important evidence."[57] Intervenors provided an expert declaration as evidence of rising seas and increased risk of flooding during the SLR period.[58]

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[52] Petition at 31, 37–38.
[53] Petition at 32, 38–39.
[54] LBP-19-3, 89 NRC __, __ (slip op. at 45–47).
[55] LBP-19-3, 89 NRC __, __ (slip op. at 45).
[56] LBP-19-3, 89 NRC __,__ (slip op. at 46). Notably, Applicant did not include this "necessary" information in the ER.
[57] *Powertech (USA), Inc.*, CLI-16-20, (slip op. at 10–11) (2016).
[58] Petition at 33–36.

Intervenors further explained that Applicant's own flood risk study found certain of the plant's flood barriers were not high enough to protect safety-related systems with an anticipated 0.39-foot sea level rise *before* its current license expires[59] and that these systems *could not be reached* without floodwaters first overtopping the cooling canal system.[60] The Board never explained why this information is insufficient to demonstrate an increased risk of overtopping during the SLR period when the ER fails to discuss this issue at all.

2. The Board concluded erroneously that state oversight will prevent overtopping and release of water from the CCS to nearby surface waters.

The Board ruled that Contention 2-E failed to demonstrate a genuine dispute of material fact or law because, in its view, state and county regulatory oversight would prevent releases of *groundwater* from the CCS to *surface waters* connected to Biscayne Bay and address material breaches or structural defects in the CCS.[61] Intervenors explained that flooding is not a groundwater-to-surface water issue and that even the most structurally sound flood wall can be overtopped.[62]

The Board further held that even if overtopping were to occur, Intervenors failed explain how it would "impair the environment" given requirements in a consent order for Applicant to maintain low annual average salinity levels and monitor and minimize nutrient levels.[63]

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[59] Petition at 37.
[60] Reply at 24 (citing FP&L, Letter, "NEI-12-06, Revision 2, Appendix G, G.4.2, Mitigating Strategies Assessment (MSA) for FLEX Strategies report for the New Flood Hazard Information," ADAMS Accession No. ML17012A065 (Dec. 20, 2016).
[61] LBP-19-3, 89 NRC __,__ (slip op. at 46) (emphasis added).
[62] Reply at 25–26.
[63] LBP-19-3, 89 NRC __,__ (slip op. at 46).

Assuming *arguendo* the consent order effectively addresses salinity and nutrients, Intervenors explained that the consent order does not address other pollutants in the cooling canal system, which is an "industrial wastewater system for operations at Turkey Point" and contains "tritium, ammonia, and sediment."[64] The discharge of any pollutant from Turkey Point into Biscayne Bay without a Clean Water Act permit is unlawful.[65] The Board overlooked or misunderstood all of these facts.

3. The Board committed legal error by assuming Applicant's compliance with a state consent order would yield "small" cumulative environmental impacts.

The Board committed legal error by relying on Applicant's compliance with a state consent order to find cumulative impacts to water resources from Applicant's CCS would be "small."[66] Intervenors raised this issue below.[67] While NRC Reg. Guide 4.2 provides applicants may assume cumulative impacts are managed "as long as facility operators are in compliance with their respective *permits*,"[68] the Board failed to explain how this guidance applies to *consent orders*, which are put in place precisely because the company violated its permits. Also, the Board overlooked or misunderstood the fact that the consent order *does not presume* Applicant will be able to remediate its environmental impacts; rather, it allows Applicant to develop a

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[64] Reply at 27–28.
[65] 33 U.S.C. §§ 1311(a) and 1342.
[66] LBP-19-3, 89 NRC __,__ (slip op. at 47 n.66 and 48) (citing LBP-19-3 at Part III.B.2.a.iii, which begins at 36). As Applicant observed, this legal issue has broad significance in NRC proceedings. Florida Power & Light Company's Answer to Intervenors' Petition for Waiver of Certain 10 C.F.R. Part 51 Regulations (July 19, 2019) at 16 (ML19200A298).
[67] Petition at 32; Reply at 30–32.
[68] Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications, Regulatory Guide 4.2, at 49 (supp. 1, rev. 1 June 2013) (ML13067A354) (emphasis added) (hereinafter "Reg. Guide 4.2").

"Plan B" if "Plan A" fails.[69] As such, the Board presumes more than the consent order upon which it is relying. Under the Board's holding, an applicant may conclude cumulative impacts are "small" even though its compliance is actually causing "moderate" impacts or worse.[70] Neither Reg. 4.2 nor the cases cited in LBP-19-3 address this point.[71] The Board's decision is in error, without governing precedent, and implicates a substantial and important question of law or policy.[72]

4. The Board erred by relying on the cumulative impacts analysis in the 2016 EIS for Units 6 and 7, which does not analyze cumulative impacts on groundwater from operating Units 3 and 4 during the SLR period.

The Board rejected Contention 4-E regarding the ER's failure to address adequately cumulative impacts on groundwater from the CCS.[73] The Board held Intervenors "ignore[d]" the ER's discussion of these impacts,[74] finding that the ER incorporated by reference (without any page citations) the cumulative impacts discussion from the 2016 EIS for Turkey Point Units 6 and 7.[75] But the board overlooked or misunderstood a critical fact that Intervenors addressed in

[69] Reply at 31–32. *See also Sierra Club v. Fed. Energy Regulatory Comm'n*, 867 F.3d 1357, 1375 (D.C. Cir. 2017) (holding the "mere existence of permit requirements overseen by another . . . state permitting authority cannot substitute for a proper NEPA analysis.").
[70] Reply at 31.
[71] *Pub. Serv. Co. of N.H.* (Seabrook Station, Units 1 & 2, CLI-77-8, 5 NRC 503, 527 (1977) (entitling substantial weigh in NRC's NEPA analysis to an *unequivocal* finding by a state agency that construction of a facility "will not have an unreasonable adverse effect" on the environment); *Pac. Gas & Elec. Co.* (Diablo Canyon Power Plant, Units 1 & 2), CLI-03-2, 57 NRC 19, 29 (2003) (no evidence that applicant would fail to meet decommissioning funding obligations); *Fla. Power & Light Co.* (Turkey Point Nuclear Generating Units 3 & 4), CLI-16-18, 84 NRC 167, 174–75 n.38 (2016) (rejecting contentions because the petitioners did not offer evidence to rebut evidentiary presumption of compliance).
[72] 10 C.F.R. §§ 2.341(b)(4)(ii), (iii).
[73] LBP-19-3, 89 NRC __,__ (slip op. at 47–48).
[74] *Id.* (slip op. at 47).
[75] *Id.* (slip op. at 47). The Board indirectly admonished Applicant for not including a page citation to the 2016 EIS, but (for unknown reasons) that did not change the Board's conclusion on admissibility. (slip op. at 47 n.67). The

the proceedings below—the 2016 EIS does not discuss cumulative impacts from operating *Units 3 and 4 during the SLR period*.[76] The differences between these units are significant; namely, Units 6 and 7 do not rely on the CCS for an ultimate heat sink. The 2016 EIS, moreover, does not even contemplate the continued operation of Units 3 and 4 beyond the current license, nor could it; the 2016 EIS predates Applicant's SLRA for Units 3 and 4 by more than a year.

The Board's error becomes obvious upon review of the 2016 EIS, which predicts increased temperatures will lead to more evapotranspiration, reducing overall recharge to Biscayne aquifer (a primary drinking water source in South Florida) and sea level rise will push the freshwater-seawater interface in the aquifer further inland; both of which further stress inland freshwater demand.[77] The 2016 EIS concludes that *Units 6 and 7* would have little impact in this new environment because—unlike Units 3 and 4—they use reclaimed water for most of their needs.[78]

5. The Board erred by requiring Intervenors to prove higher temperatures during the SLR period would increase evaporation by a "particular extent."

Contention 2-E challenged the ER for failing to adequately address cumulative impacts of operating Units 3 and 4 during the SLR period when temperatures will be higher.[79] The Board dismissed this portion of Contention 2-E, holding that Intervenors did not demonstrate higher

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Board cites to Table 7-1 in Vol. 2 of the 2016 EIS in support of its holding, which merely indicates that Applicant was "developing a plan" for remediating the hypersaline plume. That same table does not reference or contemplate continued operation of Units 3 and 4 beyond the current license.

[76] Reply at 36.

[77] Reply at 36 (citing 2016 EIS at I-5 to I-6).

[78] Reply at 36 (citing 2016 EIS at I-6).

[79] Petition at 30–31.

temperatures "would increase evaporation in the CCS to any particular extent, much less to an extent that would be sufficient to increase the CCS salinity such that it would . . . affect the environment."[80] But the Board applied the wrong standard for contention admissibility by requiring Intervenors prove the merits of their contentions. Intervenors provided sufficient support for this contention in the form of an expert declaration and Applicant's own experiences dealing with higher air temperatures.[81] The ER, in contrast, did not analyze the effect of rising temperatures at all. All that is required at the preliminary stage of contention admissibility is for petitioners to support their contention with ample evidence that the ER lacked sufficient information and analysis indicating "that further inquiry is appropriate."[82] Here, the Board abused its discretion by requiring Intervenors to prove more than is necessary for purposes of contention admissibility. The information provided demonstrates, rather than speculates, that temperatures will be higher and that high temperatures have caused adverse environmental impacts at Turkey Point. Since the ER fails to address these issues at all, further inquiry is appropriate.

D. The Board Erred in Denying Contention 3-E

Contention 3-E challenged that the ER contained no analysis of new and significant information regarding sea level rise.[83] Intervenors' arguments in this contention were simple: (1)

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[80] LBP-19-3, 89 NRC __,__ (slip op. at 46).
[81] Petition at 35–38 (citing declaration of Dr. Kopp and Applicant's "Request for Enforcement Discretion Regarding Technical Specification 3/4.7.4, Ultimate Heat Sink," (ML14204A083) (July 21, 2014), encl. at 3).
[82] *Mgmt. Co., LLC* (Palisades Nuclear Plant), ASLBP 05-842-03-LR, 63 NRC 314, 342 (2006).
[83] Petition at 39–47.

NEPA and NRC regulations require Applicant to analyze new and significant information that "would provide a seriously different picture of the environmental consequences of the proposed action than previously considered in the GEIS;"[84] (2) there is a meaningful probability of sea level rise of at least two feet, and by more than three feet if emission trends continue on their current path, during the license renewal term;[85] (3) storm surges may add one foot to "well above the highest observed historically" to the trend of sea level rise at any given time;[86] and (4) neither the GEIS nor the ER addresses how sea level rise will affect the following Category 1 or 2 issues: surface water use conflicts (Category 2) and groundwater use conflicts (plants that withdraw more than 100 gallons per minute) (Category 2) (collectively "water resources conflicts"), cumulative impacts (Category 2), and termination of plant operations and decommissioning (Category 1).[87]

The Board found Contention 3-E inadmissible.[88] The Board's decision is an abuse of discretion founded on clear errors. First, the Board erroneously concluded that Intervenors failed to raise a genuine dispute as to the new and significant information on water resources conflicts.[89] The Board held that Intervenors "provide[d] no explanation for why [frequent interchange of water from Biscayne bay and the cooling canal system] would cause conflicts in

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[84] 10 C.F.R. § 51.53(c)(3)(iv); *see also* Reg. Guide 4.2 at 49; 40 C.F.R. § 1502.9(c)(1)(ii) (agencies must supplement a prior EIS "if . . . [t]here are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts").
[85] Declaration of Dr. Robert Kopp ("Kopp Decl.") ¶ 39 (Attachment N to Petition).
[86] *Id.* ¶ 33.
[87] Petition at 41–45.
[88] LBP-19-3, 89 NRC __, __ (slip op. at 48-50).
[89] *Id.* (slip op. at 49).

water use for either surface or groundwater resources."[90] But Intervenors explained that the elimination of the "closed-loop" nature of the cooling canal system due to sea level rise will release radionuclides and other pollution in the environment, effecting freshwater availability like groundwater resources.[91] Intervenors therefore established that the ER omitted sea level rise effects on water resources and provided support for that belief.

Second, the Board concluded that, as a contention of omission, the allegation of a failure to address new and significant information regarding cumulative impacts was inadmissible because the ER in fact included the analysis by incorporating the Environmental Impact Statement for Turkey Point Units 6 and 7 ("2016 EIS").[92] But a review of the portions of the ER cited to by the Board that purportedly "incorporate by reference" the 2016 EIS reveals that the ER did no such thing.[93] The Board implied that the ER incorporated the 2016 EIS's discussion of climate-change cumulative impacts, but nowhere on the page of the ER cited by the Board does the discussion reference climate change or sea level rise.[94] Further, the ER's brief mention of the

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[90] *Id*.
[91] Petition at 44.
[92] LBP-19-3, 89 NRC __, __ (slip op. at 49).
[93] *Id*. (citing ER at 4-68).
[94] ER at 4-68 ("The EIS considered the contributing projects to be those of Turkey Point existing and proposed units, and historical point and non-point-source discharges have affected the water quality of streams and rivers near Turkey Point. The EIS considered that some water bodies near Turkey Point are listed as impaired (CWA 303[d]) and designation of the waters of Biscayne National Park as an Outstanding Florida Water.") ("The EIS analysis determined that cumulative impacts would be MODERATE, with the proposed Units 6 and 7 contribution being of small significance.") ("The EIS prepared by NRC for Turkey Point Units 6 and 7 analyzed cumulative impacts to groundwater considering the groundwater withdrawals and injections of [Turkey Point Units 3 and 4] and the other Turkey Point facilities and those from other projects and activities in the surrounding area . . . [In the EIS, the] NRC determined the cumulative impacts to be SMALL given the hydrologic characteristics of the affected aquifers, fate and transport processes, and the monitoring and management programs required by the State.").

2016 EIS is not sufficient to incorporate by reference even the limited section regarding water resources; it is certainly not sufficient to incorporate an entirely different section of the document (its discussion of climate change- or sea level rise-related impacts), let alone to incorporate the entire document.[95] Even if it could, the 2016 EIS does not analyze the cumulative impacts of climate change and sea level rise. While the 2016 EIS discusses cumulative impacts to water resources in Chapter 7, it does not discuss climate change or sea level rise as a contributing factor in the analysis.[96] Where the 2016 EIS does discuss the effect of climate change on the evaluation of environmental impacts in Appendix I, it only determines that "climate change may substantially alter the affected environment described in Chapter 2" of the 2016 EIS and that there will be "no shift in the Chapter 5-assigned impacts on water use and water quality caused by the operation of the proposed plant due to a reasonably foreseeable alteration in the environmental baseline associated with climate change."[97] Nowhere does the 2016 EIS consider the cumulative impacts of sea level rise plus the additional projects identified.

Third, the Board determined that, regardless of new and significant information, termination and decommissioning is a Category 1 issue and is therefore outside the scope of the proceeding.[98] This reasoning is in clear error and an abuse of discretion. NRC regulations require

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[95] Additionally, the ER cites to its internal citation "NRC. 2016a," which is a citation to Volume 1 of the EIS, not the entire EIS. ER at 4-68 & 10-17. Volume 1 only contains chapters 1-6, not Chapter 7 on cumulative impacts nor the Appendix I pages that the Board cited. *See* NRC, Environmental Impact Statement for Combined Licenses (COLs) for Turkey Point Nuclear Plant Units 6 and 7 (NUREG-2176) (2016) available at https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr2176/ (hereinafter "2016 EIS").
[96] 2016 EIS at 7-11 to 7-18.
[97] 2016 EIS at I-1 & I-5 to I-6.
[98] LBP-19-3, 89 NRC __, __ (slip op. at 48-49).

an ER to consider any new and significant information—for both Category 2 *and Category 1* issues.[99] "[E]ven where the GEIS has found that a particular impact applies generically (Category 1), the applicant must still provide additional analysis in its [ER] if new and significant information may bear on the applicability of the Category 1 finding at its particular plant."[100] Therefore, the fact that termination and decommissioning are a Category 1 issue should not have impacted the contention's admissibility. As there is new and significant information regarding termination and decommissioning, Applicant (and NRC Staff) had a duty under NRC regulations to consider that information.

E. The Board Erred in Denying Contention 4-E by Overlooking the 2016 EIS Finding that "Climate Change Will Provide a New Environment that the Operations of [Units 3 and 4] Will Affect."

Intervenors challenged §3 of the ER for failing to describe the affected environment during the SLR period (2032–2053), which Intervenors termed the "reasonably foreseeable affected environment." This failure rendered the analyses of environmental impacts (§4), mitigating actions (§6), and alternatives analysis (§8) legally insufficient for using the an incorrect baseline.[101] The Board found Contention 4-E inadmissible, concluding that Intervenors were "simply incorrect that the ER fails to address the effects of climate change during the license renewal period."[102] It explained that the 2013 GEIS, ER (at 4-69, 4-71) and the 2016 EIS

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[99] 10 C.F.R. § 51.53(c)(3)(iv); *Mass. v. U.S.*, 522 F.3d 115, 120 (1st Cir. 2008).
[100] Petition at 41 (citing *Fla. Power & Light Co.* (Turkey Point Nuclear Generating Plant, Units 3 and 4), CLI-01-17, 54 NRC 3, 11 (2001)).
[101] Petition at 47–58.
[102] LBP-19-3, 89 NRC __,__ (slip op. at 50).

for Units 6 and 7 all "contain," "describe," or "discuss" "the effects of climate change."[103] But this overlooks the critical question raised in Contention 4-E—whether the ER evaluated environmental impacts using the correct baseline.

The 2016 EIS found that "climate change will provide a *new environment* that the operations of [Units 3 and 4] will affect."[104] Yet the ER evaluated impacts of SLR on the "old" environment. For example, the 2016 EIS recognizes that sea level rise will stress freshwater demand inland of Turkey Point plant.[105] It further recognizes an increase in temperature will reduce overall recharge to a critical south Florida drinking water resource.[106] Yet the ER never considers the impact of operating Units 3 and 4 under these stressed conditions. Critically, the ER never considers whether Applicant's groundwater usage for Units 3 and 4 will have worse impacts on groundwater use conflicts (a Category 2 issue) when that resource is stressed in SLR period's "new environment." In contrast, the 2016 EIS addressed the issue, concluding that Units 6 and 7 would have little impact in this new environment because they use reclaimed water for most of their needs.[107] This analysis is lacking in the ER because measures the impacts of Units 3 and 4 against the wrong baseline conditions.

The ER's "descri[ption of] the effects of climate change when combined with the effects of the proposed action" at 4-69 and 4-71 (cumulative impacts analysis) does not cure the defect

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[103] *Id*. (slip op. at 50-51).
[104] Reply at 46 (citing the 2016 EIS at I-1) (emphasis added to original).
[105] *Id*. at 36 (citing 2016 EIS at I-5).
[106] *Id*. at 36 (citing 2016 EIS at I-6).
[107] Reply at 36 (citing 2016 EIS at I-6).

either. Intervenors explained[108] that these pages focus on the plant's *contribution to* climate change indicators,[109] warming trends,[110] and climate change effects;[111] whereas Contention 4-E addresses impacts of continued operation on the "new environment" that Units 3 and 4 "will affect." Similarly, the ER's vague reference to the 2016 EIS for Units 6 and 7 does not cure the defect. The Board overlooked the fact that the 2016 EIS does not address cumulative impacts of operating Units 3 and 4; only Units 6 and 7.[112]

As Intervenors stated in the proceedings below, the ER's failure to set an appropriate baseline against which to measure the project's impacts violates NEPA.[113] This is made clear in *AquAlliance v. U.S. Bureau of Reclamation*. There, an agency violated NEPA by relying on modeled historical data that was "no longer a reasonable guide to the future for water management" instead of a climate model that predicted a significant decline in water availability.[114] The same error exists here—the 2016 EIS predicts a significant decline in water availability during the SLR period, yet the ER measures Units 3 and 4's impacts on water use conflicts against today's conditions.

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[108] *Id*. at 32–37, 51. Page 51 directs the reader to the discussion of cumulative impacts at pages 32–37 of the Reply.
[109] *Id*. at 33 (citing ER at 4-69).
[110] *Id*. at 34 (citing ER at 4-69).
[111] ER at 4-71.
[112] *See* section III.C, above.
[113] *See, e.g.*, Reply at 46–47 (discussing *AquAlliance v. U.S. Bureau of Reclamation*, 287 F. Supp. 3d 969 (E.D. Cal. 2018).
[114] *AquAlliance*, 287 F. Supp. 3d at 1028.

F. The Board Erred in Denying Contention 5-E with Respect to Impacts of CCS Operations on Surface Waters and Freshwater Wetlands.

Contention 5-E challenged the ER's failure to consider the effects of continued operation of the CCS on the environment; specifically, how "the salinization of freshwater wetlands caused by the cooling canal system will impact threatened or endangered species, and otherwise harm important plant and animal habitats."[115] The Board admitted a portion of Contention 5-E relating to ammonia, but rejected the remaining portions.[116] It held the remaining portions either raised an impermissible challenge to a Category 1 issue or failed to address the consent order between Applicant and the state.[117] The Board erred on both counts.

The Board erred as a matter of law because the limitation on challenging Category 1 issues does not apply to subsequent license renewal applications.[118] The Board also erred as a matter of law by relying on the consent order between Applicant and the state for the reasons stated in Section III.C.3, above.

Assuming *arguendo* the §51.53(c)(3) limitation did apply, the NRC Staff's Draft Supplemental Environmental Impact Statement ("DSEIS") for the SLRA explains why the Board still erred. It states "the GEIS (NUREG-1437) did not consider how a nuclear power plant with a cooling pond in a salt marsh may indirectly impact the water quality of adjacent surface water bodies via a groundwater pathway. This constitutes a new, site-specific issue with respect to

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[115] Petition at 59.
[116] LBP-19-3, 89 NRC __,__ (slip op. at 53).
[117] *Id*. at 53–54.
[118] *See* Section III.A, above.

Turkey Point . . . ."[119] The Staff explained in briefing that "a waiver is not required to litigate the issue of water quality impacts on adjacent water bodies (plants with cooling ponds in salt marshes)."[120] The Staff explained that it "analyzed this *site-specific issue* for the first time in the DSEIS. *The issue was not analyzed in the GEIS*. Thus, no Commission regulation codifies the NRC Staff's environmental determinations with respect to this issue, and no waiver of any Commission rule is required to litigate it."[121]

IV. THE COMMISSION SHOULD GRANT INTERVENORS' PETITION FOR REVIEW

The Commission considers several factors in determining whether to grant a petition for review.[122] The Petition raises substantial and important questions of law and policy. The Petition seeks review of the Board's majority holding that 10 C.F.R. § 51.53(c)(3) applies to all subsequent license renewal proceedings.[123] It was not a unanimous decision, however. Judge Abreu authored a lengthy dissent, cited frequently in this decision, that warrants the Commission's attention. The resolution of this issue is important and relevant for all future SLR applications, which for reasons stated above, Intervenors assert require SLR applicants to consider site-specific impacts for all issues in their ERs, not just Category 2 issues.

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119 DSEIS at 4-21.
120 NRC Staff's Answer to Joint Intervenors' (1) Amended Motion to Migrate or Amend Contentions 1-E and 5-E and to Admit Four New Contentions, and (2) Petition for Waiver at 55 (Sep. 22, 2019) (ML19200A300).
121 *Id*. (emphasis added).
122 10 C.F.R. § 2.341(b)(4).
123 *See* section III.A, above.

The Petition two more substantial and important questions of law or policy. First, whether an applicant (and the NRC) can rely on compliance with state and county oversight in the evaluation of cumulative impacts. As Applicant observed elsewhere, this legal issue has broad significance in NRC proceedings.[124] Second, several contentions raise substantial and important questions regarding climate change and how applicants and the Commission will comply with NEPA in light of the "new environment" that this and other plants will affect.

Last, granting this Petition is in the public interest. The Turkey Point plant is located adjacent to Biscayne Bay in Southeast Florida. It is also the only nuclear power plant that uses a 5,900-acre CCS as the ultimate heat sink for its operations. This is also the source of a hypersaline plume that is harming groundwater and surface water resources in a region where water resources are already stressed. It is in the public's interest to ensure the NRC makes an informed decision about extending Applicant's license until 2053 when, as the NRC has already found, there will be a "new environment" that the plant will affect. With respect, that analysis is lacking and there appears to be no interest in taking a hard look at the reasonably foreseeable impacts of operating Units 3 and 4 when the affected environment will be more stressed due to increased temperatures and higher sea levels. Granting this Petition and giving Intervenors an opportunity to present their case at a hearing would only further the public's interest, particularly when the SLR would not take effect for another 13 years.

[124] Florida Power & Light Company's Answer to Intervenors' Petition for Waiver of Certain 10 C.F.R. Part 51 Regulations (July 19, 2019) at 16 (ML19200A298).

V. CONCLUSION

The Commission should remedy these clear errors in material facts and departures from governing precedents and established law, which raise substantial and important questions of law and policy warranting review.[125]

Respectfully submitted,

<u>*Executed in Accord with 10 C.F.R. § 2.304(d)*</u>
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August 9, 2019

[125] *See* 10 C.F.R. § 2.341(b)(4).

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE COMMISSION

In the Matter of	)	Docket Nos. 50-250 & 50-251
FLORIDA POWER & LIGHT COMPANY	)	ASLBP No. 18-957-01-SLR-DB01
(Turkey Point Nuclear Generating Station, Unit Nos. 3 and 4)	)	August 9, 2019
(Subsequent License Renewal Application)	)	

CERTIFICATE OF SERVICE

Pursuant to 10 C.F.R. § 2.305, I certify that, on this date, copies of the foregoing "Friends of the Earth's, Natural Resources Defense Council's, and Miami Waterkeeper's Petition for Review of the Atomic Safety And Licensing Board's Rulings in LBP-19-3 and LBP-19-06" were served by Electronic Information Exchange (the NRC's E-Filing System) to all parties of record in the above-captioned docket.

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Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Florida Power and Light

Docket Number: 50-250-SLR and 50-251-SLR

ASLBP Number: 18-957-01-SLR-BD01

Location: Rockville, Maryland

Date: Monday, September 9, 2019

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ATOMIC SAFETY AND LICENSING BOARD PANEL

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HEARING

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In the Matter of: : Docket Nos.

FLORIDA POWER : 50-250-SLR

& LIGHT COMPANY : 50-251-SLR

: ASLBP No.

(Turkey Point Nuclear : 18-957-01-SLR-BD01

Generating Units 3 and 4) :

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Monday, September 9, 2019

Nuclear Regulatory Commission

Hearing Room T3-D50

11555 Rockville Pike

Rockville, Maryland

BEFORE:

E. ROY HAWKENS, Chair

DR. SUE H. ABREU, Administrative Judge

DR. MICHAEL F. KENNEDY, Administrative Judge

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able to reinvigorate thinly-supported original arguments later in a proceeding.

JUDGE HAWKENS: Thank you.

Do counsel at this point want to take a 10-minute break or do you want to push through for the next contention?

I'll start with Joint Intervenors.

MR. RUMELT: Your Honor, I think Joint Intervenors will need to switch our counsel table. So, it may make sense to take a short break.

JUDGE HAWKENS: All right. Let's take a 10-minute break. Let's reconvene at 11:30.

(Whereupon, the above-entitled matter went off the record at 11:18 a.m. and resumed at 11:30 a.m.)

JUDGE HAWKENS: We're going to start now with now with Contention 5-E(b). It's conceivable -- excuse me, with Contention 6-E, and it's conceivable we could do both 6-E and 7-E before the lunch break. But we'll finish 6-E and see how Counsel feel at that point. 6-E, I believe, Mr. Rumelt?

MR. RUMELT: Rumelt, yes.

JUDGE HAWKENS: Is going to be -- how much time would you like for rebuttal, sir?

MR. RUMELT: I would like three minutes

for rebuttal, please.

JUDGE HAWKENS: All right.

MR. RUMELT: Your Honors, Contention 6-E relates to the surface water impacts by the groundwater pathway from the cooling canal system. And Your Honors' first question asked how is this discussion in the DSEIS different from the environmental report. And I think the simple answer, there was no discussion of this issue in the Environmental Report. And so everything is new.

Moving on to the second bullet point, the Board asked can previously available information be used to challenge a new discussion in the DSEIS. Well, first, I think we do have here a new discussion in the DSEIS. And I'll point the Board to the preamble from the Board's promulgation of the rules that are governing this proceeding. And this is at 77 Federal Register, and the specific page cite is 46566.

In there, the Commission said, and I quote, An NRC document with a new conclusion based on previously available information not contained in the Applicant's environmental report, such as information from a previously available but unreferenced study, might be a proper subject for a contention.

So what's clear from the preamble is that an Intervenor can raise new contentions based on previously available information. So it doesn't foreclose that possibility.

Now, we recognize that there's not any case law directly on point here with the specific facts here. But there is case law that recognizes this principle that staff's discussion in analysis is different. It needs to be treated separately as far as information goes from information that may have existed in the past. And I'd point Your Honors to Powertech case for that proposition.

Specifically, the Board held there that the Intervenors need not respond to new information when the information's actually -- until, sorry, the information is actually used by the NRC staff to form its conclusions on impacts in the DSEIS, okay.

In addition, the Board wrote that there's no way for Intervenors to know what use, if any, NRC staff may make of a response to a request for additional information or a study in the DSEIS.

And an Intervenor is entitled to see the DSEIS and then file any new or amended contentions, based on what appears in the DSEIS. To do otherwise would place an impossible burden on the Intervenor and an unreasonable requirement that the Intervenor divine what use, if any, the NRC staff will make of that information in the DSEIS.

And that's really the position that Intervenors were placed in here. If we look to the environmental report -- well, going back a little bit. We heard argument this morning about modeling studies that were performed in order to determine how much water to add to the cooling canal system to deal with the salinity issue. This is the freshening effort.

And the model that was referenced was work done by Tetra Tech. And if you look through the reference list, in the environmental report, this is not a single reference to any Tetra Tech study, let alone the 2014 study that the staff pointed to in the DSEIS.

In addition, we also heard argument kind of one side pointing to the other, the other pointing back about whether this information is available and how Intervenors would obtain it. We heard the NRC staff say well, you have to go to FPL. FPL said, well, you really have to go to the regulators.

And at the end of the day there was, you know, a statement from Counsel for FPL that our experts who were retained for this matter were able to get a copy or obtain access to the report through litigation, which at least my client certainly wasn't involved in.

And if the standard is you have to go through litigation in a separate proceeding in order to obtain that information, that cannot be considered available to anybody in the public. That's a significant effort, obviously, and one that no Intervenor should be required to go through.

With respect to, you know, the modeling effort that's been done and the conclusions that are in the DSEIS, we're really faced with a significant problem that I think the Board has recognized. There are several of the questions that it's presented. We have a situation where the NRC staff in the DSEIS has recognized actual data which was not included in the environmental report.

And the actual data is showing that salinity levels have not gone down as predicted in the very modeling that the NRC staff is relying on in the DSEIS. And there's a statement recognized by the staff again in the DSEIS that the modelers anticipate that more favorable climatic conditions, i.e., less severe dry seasons, with that change, the addition of upper Florida and aquifer water, should help to reduce CCS water salinities to 34 PSU, practical salinity units.

And that's the target, that's the goal that FPL has to meet. And there's no evidence on the record, and you know, in the ER and specifically here in the DSEIS that that salinity level will ever be reached. There's no evidence that anybody considered what favorable, more favorable climatic conditions would be required in order to meet the 34 PSU standard.

And then second, there's no effort to look at whether any of those conditions would exist in the reasonable, in the future, including the subsequent license renewal period.

And so the conclusion that's been made by the staff in the DSEIS with respect to a number of different environmental impacts is fundamentally flawed. And ultimately, if you take, if you look at the modeling and you understand that it's flawed, it's not working. They haven't met their targets, and there's no effort to determine whether or not they will be able to meet it, understanding data as it exists today.

All that the staff is left with is an assumption that continued oversight is going to rectify the situation somehow. And as we pointed out in our briefing, there's a DC Circuit case that's binding on the NRC, a NEPA case that says agencies cannot rely on the mere existence of permits and oversight to avoid the responsibility of conducting a proper NEPA analysis. And that's what we have here.

So if we look to the rest of the Board's questions, does, you know, does the staff rely solely on the existence of this oversight, the answer is yes.

JUDGE HAWKENS: That's your view.

MR. RUMELT: That's our view.

JUDGE HAWKENS: All right, thank you.

MR. RUMELT: And it's the logical conclusion from what's been said in the DSEIS.

All right, and then Your Honors asks how does the staff reconcile this difference between what's been actually modeled and the outcome that has been measured in the DSEIS. And we're not aware of anywhere in the DSEIS that there is any reconciliation of those two competing facts.

Your Honors ask about climatic assumptions that were used in this 2014 Tetra Tech analysis that, again, was not included or referenced in the environmental report. And to the best of our knowledge, the climatic assumptions appear at page two to three in that Tetra Tech report. And it appears to be based off 22 months of hydrological and salinity data from September 2010 to May 2012.

And, again, we go back to the understanding that the modeling has not been predicted, and it will take more favorable climatic conditions in order for that modeling to, I'm sorry, in order for the efforts to reach the 34 PSU to be fruitful.

And last, the Board asks whether the DSEIS mentions, or I'm sorry, whether the assumptions in the modeling reflect the 30.5 degree increase in temperature that is recognized elsewhere in the DSEIS, whether that's built into any of the modeling or has been considered. And Your Honors, we're not aware of any place where that has been addressed.

I have no further.

JUDGE KENNEDY: Excuse me, do you have any support for the other side of the equation is that -- do you have any support for the statement that would say this target cannot be met in the ensuing 12 years or 13? I can't do the math, but we have at least more than a decade going forward. Is there anything in your pleadings that would lead us to draw the conclusion that it could not be met?

MR. RUMELT: Your Honor, we submitted with our motion for new and amended contentions three expert reports. I believe two of those expert reports address the issue that you're raising directly. One of those reports is by Dr. William Nuttle, a hydrologist. And Dr. Nuttle addresses the issue of the more favorable climatic conditions specifically and references new studies on the future, what we can anticipate the future will be in terms of climate.

In addition, the Intervenors submitted the modeling report of Mr. E.J. Wexler. And Mr. Wexler's report demonstrates that under the current plan to freshen the canal system, it cannot work. And I would refer to Mr. Wexler's report for all of the information in support of that opinion.

JUDGE KENNEDY: Thank you.

MR. RUMELT: You're welcome.

JUDGE HAWKENS: Mr. Turk, you may proceed.

MR. TURK: Thank you, Your Honor. I think we're going to continue to split time 50-50 with the Applicants.

JUDGE HAWKENS: Very well.

MR. TURK: The difficulty with all of the four new contentions, 6-E, 7-E, 8-E, and 9-E, is that the Intervenors did not cite specific information or data in support of any of the four contentions. They had one section in their pleading section, IV(b), which contained new information. That new information was very extensive.

It included some things that were not submitted in support of the contentions, such as the Miami-Dade County petition, some other proceedings going on outside of the NRC's purview. They cited three reports that apparently had been submitted, or earlier versions had been submitted by another Intervenor in this proceeding. Those are the reports by Fourqurean, Wexler, and Nuttle, whose reports had been relied upon by SACE, S-A-C-E in support of their contentions.

So it's very difficult to say where in the new information submitted by the Intervenors is the specific support upon which they're relying in support of any one of these contentions. So that's, that'll be true for 6-E, as well as all the others. So that's the first problem.

The case law at the Commission is clear that the Board and other parties are not required to expend their resources and time trying to figure out where in the mass of information submitted by Intervenor are the specific support for a contention. That is something that the Intervenors had the burden of demonstrating and pleading, which they have not done.

The Intervenors claim that the staff relied solely upon governmental efforts by the state of Florida and Miami-Dade County to achieve the results of retraction of the plume and freshening of the CCS. That's not true, that's one of the factors that the staff considered.

As I mentioned previously, the staff also considered the groundwater modeling that's been done, as well as the results of the freshening efforts that have taken place to date. So to say that we only are relying on the state and county is wrong.

But there is another point to be made, and that is that Commission case law establishes that it is appropriate for the Board and the parties to assume that state regulators will take, will do what is necessary for them to do to achieve their desired results. And so reliance on the state and county to take regulatory actions if necessary is not improper.

JUDGE KENNEDY: Mr. Turk? Could you help us understand a little better why the, let's take the modeling for example, provides the staff with confidence that these target objectives will be met?

MR. TURK: Yes, Your Honor. So the

cognizant regulatory authorities for the Clean Water Act are either EPA, or in this instance, the state of Florida. We rely upon those agencies to establish appropriate goals and to assure themselves that the technical analyses that are provided by a company, here Florida Power and Light, are adequate.

We do not question whether the state was correct or not in accepting results or in getting whatever modifications to the studies that they may have determined to be appropriate. We do review those studies. We look to see if they're reasonable, we look to see if they support a certain conclusion. But we don't go behind the scenes and say, well, why did you model it this way rather than another way, because that's the state's authority.

JUDGE KENNEDY: Do you, does the staff consider any uncertainties in those models, and do they -- I'll let you.

MR. TURK: Yes.

JUDGE KENNEDY: But I guess what I'm curious about is, you know, what possibly is at work here is there's different climatic conditions, there may be suggestions that there need to be different refreshening rates and freshening rates.

Does the staff get involved in reviewing the models, in looking at was there any uncertainty studies done. Is there, are these bounding analysis, are they, do they cover the range of climatic conditions, on and on and on? I mean it's not clear to me from the DSEIS that this was done.

MR. TURK: We do look at the uncertainties, Your Honor, and the uncertainties are reflected in the draft SEIS. But we don't do a detailed probe of their analysis as if it had been submitted to the NRC for evaluation and acceptance. That's up to the state.

JUDGE KENNEDY: My only recollection of what's recognized in terms of uncertainties is a recognition that there's uncertainties in the models. Is there any more characterization than that in a DSEIS?

MR. TURK: I believe the DSEIS recognizes not just uncertainties in the model, but also uncertainties in the conditions, the assumptions that go into the model, as well as uncertainties in the product of the model.

JUDGE KENNEDY: But there was no attempt to quantify the impact of those uncertainties on model results.

MR. TURK: Not in a quantitative sense,

Your Honor. But that does affect the qualitative assessment of the projected results.

JUDGE KENNEDY: Yeah, I guess I'm just trying to get at the staff's confidence in, again, meeting the objective. And one of the points you, one of the aspects you point to is the modeling, you know, what played a factor in the staff's acceptance of meeting the objective.

And yet there still seems to be uncertainties that weren't evaluated or quantified, and I guess I was really trying to, maybe I missed it somewhere.

MR. TURK: No, you're correct, Your Honor. But we do consider the uncertainties, as I mentioned, and we don't come up with a flat answer. We recognize that there might be some variation in the results due to uncertainties. And that's reflected in our overall finding.

JUDGE ABREU: And where did --

MR. TURK: And in our discussion.

JUDGE ABREU: Where in the EIS is there a discussion of that uncertainty analysis? So if I wanted to understand the modeling, the range of the modeling thinking, where in the EIS could I see that?

MR. TURK: Your Honor, for that I'd have

to look over the lunch break and get back to you.

JUDGE ABREU: Okay, that'll be fine.

JUDGE KENNEDY: Maybe this will be a lunch break question too, but you also referred to data. You said modeling and data. When you say data, what are you referring to? Is this plant data that's been taken, or maybe I misheard you, sir. I heard that the staff relied on modeling and data.

MR. TURK: So to the extent that I was referring to data, those would be the results of groundwater monitoring that had been conducted.

JUDGE KENNEDY: So groundwater monitoring data.

MR. TURK: Yes.

JUDGE KENNEDY: Okay, thank you.

JUDGE ABREU: And so just specifically for Contention 6, does the modeling describe, there's a lot of the modeling description on 3-49 in the DSEIS. Does that modeling assume that the groundwater withdrawal rates during the SLR term will be no more than are currently allowed under the local regulators?

MR. TURK: Currently allowed, yes. The Intervenors are mistaken. They say that we assume that withdrawal will not be any greater than is currently being conducted. In fact the, what we used was the actual affirmative maximum, which is greater than the withdrawals that are being made now, both by Florida Power and Light as well as other users.

JUDGE ABREU: So it was modeled at that, using that assumption.

MR. TURK: Yes.

JUDGE ABREU: And can I tell that from what is in the EIS?

MR. TURK: Yes.

JUDGE ABREU: And where is that?

MR. TURK: I have to get you page references, but there are several places where we talk about use of the maximum permitted level provides a conservative bounding number.

JUDGE ABREU: Okay, so it was limit, so it was -- so the next question was then were there model, was there any modeling of any groundwater withdrawal rates greater than currently permitted?

MR. TURK: Not that I'm aware of, and there's a good reason for that. At least from the staff's perspective, we don't know if the state or other regulators might in the future authorize greater withdrawals than they do now. Where would we stop? Is it a two percent increase, a 10 percent, 100 percent? We have no way to say what might happen in the future.

JUDGE ABREU: Isn't that essentially what a NEPA analysis does --

MR. TURK: No.

JUDGE ABREU: Is look into the future?

MR. TURK: It does not look at speculative conditions. We can only assess what we know to be true. We know that FPL is allowed to take out a maximum, as stated in their permit. Let me give you an example.

Florida Power and Light is authorized to take out approximately 28 million gallons per day from the Biscayne Aquifer for both freshening efforts and other uses. They're currently taking out, I believe 19 million gallons per day, which is far less than they're authorized.

With respect to freshening efforts, they're authorized -- within that number they're authorized to take out 14 million gallons per day. They're taking out 13.

So their current withdrawals, and in fact those withdrawals may have decreased, I don't know, but in the SEIS we mentioned that they're currently taking 13, which is less than the maximum permitted level of 14 million gallons per day. So that's the maximum of what we know to be a fact that we can reliably discuss in the EIS.

JUDGE ABREU: So when we talk about then the climate conditions, in the EIS there is mention about the potential for the average temperature to increase by about three and a half degrees Fahrenheit between now and 2050. That was in the EIS. But in the discussion of the modeling, it talked about an assumption of more favorable climate conditions.

So how -- put that together with, you're talking about, because you're saying something about we really can't assume what might happen in the future, yet we have information that says these things are expected to happen. So where, how does that all fit together?

MR. TURK: The statement, the second statement you refer to, which talks about more favorable climatic conditions, would have a different, or might have an ameliorative effect. That's simply a qualitative statement that does not affect our finding.

It's simply a recognition that recently, there had been drought conditions and there had recently been significant hurricanes, both of which affected the evaporation rate and the salinity levels in the CCS. So the statement you referred to is simply a recognition that as conditions change, there's a different outcome. It did not affect our assessment of the impact of the CCS.

JUDGE ABREU: So that assumption was not used in the modeling?

MR. TURK: It's not something that was -- that came from the modeling. I believe that was just a staff qualitative statement saying weather conditions can affect the outcomes.

JUDGE ABREU: So were climate conditions considered as part of the modeling?

MR. TURK: My --

JUDGE ABREU: Since that affects salinity, it sounds like something that has an impact on the output of that model or the --

MR. TURK: One moment here.

JUDGE ABREU: Yeah.

MR. TURK: So I'm very lucky to have Mr. Folk with me at the table, I thank him for his help on this. The consent order and consent agreement, which were issued by the state and the county regulators, require FPL to achieve certain results within ten years. Conditions in the year 2050 don't affect that. The current requirements are that by 20, I guess it would be 2027-ish, maybe 2028, that the conditions must meet the state and county's goals. So the weather in 2050 wouldn't matter to affect that.

But he also, Mr. Folk also informs me that the statement in the EIS that discussed potential future weather conditions might have an ameliorative effect -- I shouldn't say that word, I stumble over it every time I use it. That was simply to indicate that a return to more normal, historically normal weather conditions, would result in more favorable conditions in the CCS.

But it's not meant to say that our analysis depends upon that happening.

JUDGE ABREU: All right, where in the EIS can someone tell what assumptions were made for the modeling? That -- you -- let me make sure I clarify. Earlier you said that the modeling was a factor, the results of the modeling were a factor in the staff's decision.

So let me back up a second. Earlier you said that based on the groundwater modeling, that that was a factor in making your determination that the impact would be small. Is that a correct?

MR. TURK: Yes.

JUDGE ABREU: Okay, so if the modeling was used, where can I find in the EIS the assumptions used for the modeling?

MR. TURK: The EIS itself does not discuss all the details of the modeling. But it does give a reference to where the reader can go to find more information on that point.

JUDGE ABREU: And that is?

MR. TURK: So for instance, we have three references to the Tetra Tech models. The reference is Tetra Tech 2014, 2014-A, and I believe 2017.

JUDGE ABREU: And what is --

MR. TURK: Oh, 2016, I'm sorry, 2016.

JUDGE ABREU: And how does an outsider get those, those models? Get those references?

MR. TURK: If I'm not mistaken, I'd look at the EIS to be sure, but I believe they're in ADAMS, in the NRC's documents access.

JUDGE ABREU: So that even though there was no ML number, there is an ML number. So you were mentioning earlier about making sure to reference things clearly. But -- so if you could get us those ML numbers, that could be helpful.

MR. TURK: Your Honor, I'm looking in the draft SEIS.

JUDGE ABREU: Yeah.

MR. TURK: At page 6-31.

JUDGE ABREU: Okay.

MR. TURK: And there are --

JUDGE ABREU: 6-31, okay, that's reference section.

MR. TURK: Five different Tetra Tech reports.

JUDGE ABREU: Yup.

MR. TURK: Each of which either has an ADAMS accession number.

JUDGE ABREU: Okay, great.

MR. TURK: Or a website where the document can be seen.

JUDGE ABREU: Okay, great, excellent. All right, so in the, so I were to pull up those references, I would get, within them I would be able to find a list of the assumptions made that were used in the modeling.

MR. TURK: You should find a description or narrative at least of the assumptions.

JUDGE ABREU: Okay.

JUDGE HAWKENS: You had said, Mr. Turk, that the staff takes a look at the models. It sounds like a high altitude assessment for reasonableness, is that correct?

MR. TURK: The staff employs hydrogeologists and groundwater specialists, who I'm sure take a great interest in these kinds of reports. So they read them and they look not just to see what's the bottom line, but they look at how the modeling was conducted. I'm sure they look at the assumptions that went into it. And they reach their own level of comfort with those reports --

JUDGE HAWKENS: There's really an independent assessment, then, by the NRC staff of the report and the reasonableness of the model?

MR. TURK: Yes. Although no special finding is made on that, because we do rely upon the state to whom those reports were submitted in the first instance. But in order to inform our decision on what are impacts, our people would look at those reports, at those reports and at the modeling, to be sure they're satisfied that they can rely upon them.

JUDGE HAWKENS: So am I correct in saying you, the staff, reviews it so it will have a level of confidence that the models are reasonable?

MR. TURK: Yes, Your Honor.

JUDGE HAWKENS: But that conclusion is not reflected in the DSEIS, is that correct?

MR. TURK: It's implicit. The fact that

we cite it and rely upon it indicates that we're satisfied with it. If we were not, we would have gone back to FPL and said we looked at this report, it's bogus, you need to do more. But I'm not aware of any time that that's happened in this application in respect to Tetra Tech's work.

JUDGE HAWKENS: Thank you.

JUDGE ABREU: Returning to an earlier topic we had, which is what defines a hard look. So when we're discussing, say, this contention, what, how would you define what would indicate a hard look had been taken?

MR. TURK: So I would supplement what Mr. Wachutka mentioned to you. To me, a hard look means that we look at all relevant information and analyses that could help us in our evaluation of an impact. So we go out, we ask an applicant, a request for additional information. If we find that the environmental report is lacking information or is not satisfactory to us, we may use our own knowledge of reference texts.

We may compare, for instance, a groundwater modeling report to established textbooks in the field to determine is this an acceptable and previously accepted approach to do modeling. I'm not saying that was done here, but that's the kind of question we might ask when we see a report.

And we'd look for other information that becomes available to us, not from the applicant but from other sources or that are publically available to anyone, so.

JUDGE ABREU: So what I'm hearing you say is that we're going to consider all the factors that matter.

MR. TURK: Yes.

JUDGE ABREU: Is kind of the important part.

MR. TURK: All the factors and all the information that's available.

JUDGE ABREU: For that specific topic.

MR. TURK: Yes.

JUDGE ABREU: And so in the EIS, to document that that hard look occurred, would it be correct to say that we would expect to find here are the factors we considered before making our determine -- we, I'm speaking in your terms, not us. Here's the, the staff would say here's what we looked at, and here's the assumptions we made, if we had to make any assumptions. But here's the data and here's our reasoning.

MR. TURK: Yes, that's pretty --

JUDGE ABREU: Is that what you would say is a hard look?

MR. TURK: Yes.

JUDGE ABREU: Okay.

MR. TURK: Now, I can't say that every bit of data would be explicitly discussed in the EIS. That'd be far too much to put into a single document. But we provide the reference list, and that reference list comprises the information that we look at.

JUDGE ABREU: So in the, in Contention 6, the way it's phrased is that, I believe in the, at the end of the discussion of the contention, or not the contention, of the impacts on surface water via groundwater, it basically said that upon consideration of the existing requirements in the county and state oversight, we find small.

But before that was a big discussion of the modeling. Even though the concluding sentence based on what the regulators are doing, we think it's small, would it be correct to say that what they really meant to say was based on our look at all the modeling and all the factors considered, as well as the fact that the state and county are regulating this, we think the impact is small?

MR. TURK: That's correct.

JUDGE ABREU: So the way it's phrased didn't really communicate the full decisionmaking of the staff, in a sense.

MR. TURK: Well, that's only one of the statements that appears in the EIS.

JUDGE ABREU: True, but right at that kind of critical point.

MR. TURK: Right at that point, yes.

JUDGE ABREU: It made it sound a bit like, well, they've got it regulated, so our impact is small. Even though there was all this other discussion before it, it wasn't clear how the two were integrated, based on the phrasing in the EIS.

MR. TURK: In that particular location, correct. But as we mentioned in our response to the contentions, the staff also had a lengthy discussion in chapter 3 of the EIS, which talks about the existing --

JUDGE ABREU: The 3-49 page.

MR. TURK: Yes.

JUDGE ABREU: I'll believe you're referring to.

MR. TURK: I'll accept that, Your Honor, I don't have it right in front of me.

JUDGE ABREU: But that's a page where there was much discussion about the details of modeling.

MR. TURK: That's right. And also even in Chapter 4, there's more discussion of modeling.

JUDGE ABREU: Mm hm.

MR. TURK: So the one particular segment by itself is out of context. It's not the complete basis for the staff's finding.

JUDGE ABREU: Okay, thank you.

MR. TURK: Your Honor, I don't really have much more. I think I've gone far enough. If you have any specific questions you'd like me to answer, I can.

JUDGE KENNEDY: Yeah, I guess I, somewhere between 6, 7, 8, and 9, I really want to keep, bring back up the topic of the staff's conclusions. I think we've been talking about the modeling. You referred to modeling and data, and then there's the modeling the data and reliance on state and local government oversight and enforcement.

I think I'm still struggle with trying to get a sense of if we take the modeling, how does the staff communicate to the public that what they see in the modeling provides them confidence that the targets are going to be met in the context of the data that was available or has purported to be available that says they may not be met?

Then there's data that you reference, which I think I need to understand exactly which data you're referring to. And then the overall reliance on state and local oversight intervention. Are those three equal poles that the table sits on, or are they, is the, is one much greater than the other? How should we view that?

MR. TURK: So in our normal review, both safety and environmental, an applicant will submit reports to us from modeling results to us. And we will then evaluate it as a matter of first impression. You may, Your Honor, you may be familiar with that practice where, no matter what the technical issue, we look at a report and we reach a judgement on it and we discuss the adequacy of the report.

We'll send out requests for additional information about that report specifically. These reports are not submitted to the NRC for our evaluation and acceptance, they were submitted to the state of Florida. The Clean Water Act, in fact, prohibits the NRC from making technical judgements about the adequacy of things like that.

There's established case law, I believe

there's the Limerick decision, where the Commission in fact cited discussion, I believe it was Senator Muskie, who clearly stated, I can get the citation if you give me a moment, but clearly stated that federal agencies are prohibited from second-guessing or from challenging the EPA determinations or state determinations on matters of groundwater quality, matters that are covered by the Clean Water Act.

So it's not our place to challenge the report and assess specifics regarding its adequacy. But we are entitled to look at the report, determine if we're comfortable relying on it, and to describe the environmental impacts that result from reliance on that report.

JUDGE KENNEDY: So if you were to pick one of those points, if I was to ask you what gave you the confidence in 2028 that the objectives in the CCS salinity would be met, what do you point to?

MR. TURK: I would point primarily to three things. One is that the results of the freshening conducted up to the point of the DSEIS publication. And later we'll talk about up to the date of FSEIS. But the freshening results had been successful. The governmental agencies at the state and county levels are performing their role.

They're involved in regulatory oversight, and they have the authority to do what's necessary to reach those goals. And we've seen the modeling reports, which give us confidence in their prediction. And that's what those reports do, they predict that following a certain remedial course of action will achieve the results desired by the state and county.

JUDGE KENNEDY: So all three.

MR. TURK: Those three.

JUDGE KENNEDY: Thank you.

JUDGE HAWKENS: Anything else, Mr. Turk?

MR. TURK: No, Your Honors, thank you.

JUDGE HAWKENS: I think your seven and a half minutes has expired.

MR. TURK: I'm sure they have.

JUDGE HAWKENS: Mr. O'Neill, you may proceed.

MR. O'NEILL: Okay, thank you, Your Honor. I want to begin just by emphasizing some key legal points at the outset here, and respond to the notion that FPL is not meeting the objectives. It is in full compliance with both the consent order and the consent agreement. That encompasses the CCS freshening activities, the hypersaline plume extraction activities, and other things required by the consent order and consent agreement.

And it has not missed any interim salinity target. In fact, FPL is only about just past midway through the four-year initial period prescribed by the consent order for the salinity reduction, you know, meeting the target of 34 PSU. So that initial target I think is May 2021. And again, you know, they have seen substantial reductions of salinities down to the order of 50, 51 PSU.

And I think it's important to note when we talk about the issue of public confidence. That confidence, you know, from our perspective, comes very much from the legal framework that is in place here. And that being the consent order above else.

And because if further actions prove necessary down the road, say they, FPL does need to, you know, introduce additional water, whether it's through more wells or increased pumping rates, they still would be in compliance with the consent order. I mean, the consent order specifically recognizes the possibility that the target may not be achieved. And we can't, you know, say it won't or it will at this juncture, but it recognizes that possibility.

I think it's paragraph 20A, and it's quoted on page 3-49 of the DSEIS, that if FPL fails to reach an average annual salinity of at or below 34 PSU by the required time periods, then the consent order requires them to submit a plan within 60 days of that failure to the FDEP detailing additional measures and a revised timeframe for achieving the 34 PSU target. So that is specifically built into the consent order.

And the other thing I might add is that the results of the freshening activities are reported to the state annually, and daily water quality and salinity data is actually available, you know, to the state agencies. And at this point, they haven't expressed any concerns relative to FPL's progress in meeting the objectives or, you know, recommended any course corrections.

So again, from our perspective, that's a significant source of confidence.

JUDGE HAWKENS: Mr. O'Neill, does the state have the ultimate authority to direct you, direct FPL to shut down if during the subsequent license renewal period it becomes clear you're not able to achieve the environmental goals?

MR. O'NEILL: That I do not know, Your Honor. I don't know if that would factor into the Public Service Commission process or not, I don't, yeah. I've been informed that it would likely involve, you know, some regulatory compliance, excuse me, fines and alternative mitigation strategies would have to be developed, so yeah.

JUDGE HAWKENS: All right.

JUDGE ABREU: But if you did not have a permit from them could you operate?

MR. O'NEILL: No, the permit is definitely required, yes.

JUDGE ABREU: So theoretically, if they withdrew the permit, you'd shut down.

MR. BESSETTE: One moment, Your Honor.

MR. O'NEILL: Yeah, Your Honor, I just want to emphasize again that, you know, the consent order does contemplate this possibility, and the prescribed action is to develop an alternative strategy, you know, for achieving the 34 PSU in a revised timeline. So it doesn't contemplate shutdown.

JUDGE ABREU: But --

MR. O'NEILL: But to answer your question, certainly, you know, the company does have to have, you know, a valid NPDES permit or a permit that governs cooling water discharges to the canals, yes.

JUDGE ABREU: Right, so in theory, if for some reason things just went horrible, the state could just, could take away the permit or, you know, say you're not fulfilling the consent order and do whatever they do.

MR. O'NEILL: But again, we have no reason, we believe that is unlikely hypothetical, and it's all, yeah.

JUDGE ABREU: But in the sense of possibilities, it is on the list. Unlikely, but.

MR. O'NEILL: The state can ultimately, yeah.

JUDGE ABREU: They do have that control over you, is what I'm --

MR. O'NEILL: Control to issue the permit, yes.

JUDGE ABREU: Yes.

MR. O'NEILL: And to modify the permit if necessary, yeah.

You know, another point I wanted to address is as relates to, you know, future climactic conditions. And you know, there's this discussion of well, how do we know what the conditions will be like. And I think this board, in Footnote 71 of LBP-19-03, said that NRC regulations require that environmental reports, and by extension the staff's draft SEIS, you know, must describe in detail the affected environment around the plant, not the reasonably foreseeable affected environment during the SLR period.

So I think that's just consistent with the broader NEPA principle that, you know, we can't engage in crystal ball inquiries about whether conditions will be wetter or drier, you know, 30 years from now. We just simply can't know that with any certainty, you know, and that really goes beyond NEPA's rule of reason.

JUDGE ABREU: And those, the Tetra Tech models that are referenced in the EIS, if one were to look in those references, what type of information would one find, such as the assumptions that were input for the model, that type of thing? Are those all available in detail in there?

MR. O'NEILL: Yes, I think you'd find fairly detailed descriptions of the models. You know, for example, the water and salt balance model, that was developed in the 2012 timeframe, in connection with extended power uprate proceeding.

And there was a report issued that's publically available through the state's websites, that 2012 pre-uprate comprehensive report, that provides quite a bit of detail on the water and salt balance model.

And I know FPL also describes the model in its annual remediation and our restoration status reports. And it's certainly not going to include, you know, the spreadsheet itself, but it is going to describe the basic assumptions.

JUDGE ABREU: But it would give someone who wanted to say, gee, does this make sense --

MR. O'NEILL: Exactly.

JUDGE ABREU: Be able to go in and say, okay, I can see what their thinking process was.

MR. O'NEILL: Yes, yes, Your Honor. And on that point I did want to emphasize as well that the model that's related to, you know, the salinity of the CCS system is a stochastic model. So it basically is based on past weather sequences.

So it basically kind of assume that the past weather will predict the future. So it encompasses things like, you know, precipitation amounts, temperature gradients, you know, seepage in and out of the canal system, that type of thing.

And there definitely has been some confusion about the discussion I think on page 3-49 of the DSEIS, because that talks about the model I think in the 2014 timeframe. And that was the initial model developed in 2012, which is based on two years of data, weather data. And one of the years was wetter than normal, and so it was a bit skewed in that sense.

And FPL has since incorporated I think seven or eight years of weather data, and they recalibrate the model annually. And they actually do calibrate the models, kind of predictions or simulations against actual data, you know, water level data, salinity data from the canal system and the match is very good. It's been described to me as a very tight model. So we disagree vigorously with the notion that the model is defective or deficient, so.

I had a number of issues I would have liked to have gotten into, if it's --

JUDGE HAWKENS: I'll tell you, why don't you take four more minutes.

MR. O'NEILL: Okay, Your Honor. Yeah, Your Honor, one issue I really did want to touch on is the, and again, it relates to the staff, and it's ultimately their responsibility, but the nature of their review or obligations under NEPA, I think there's some very instructive NRC case law on this point.

Basically holds that the NRC has to exercise its independent judgement in identifying and assessing the reasonably foreseeable impacts of a proposed licensing action. So in doing so, it's relates to groundwater and that our discussion earlier really focused on the issues here.

I'm not disputing that our discussion earlier has significance, serious significance on Contention 7-E. But we can't get away from the fact that Contention 6-E also addresses the staff's ultimate conclusion that's based on oversight in freshening and remediation of the cooling canal system impacts.

It's the same core set of facts and issues. And it just depends on which issue you're looking at from there. You make one turn it goes to surface water. The other way it's groundwater.

There was a statement that things are progressing as planned. I see my time is up.

JUDGE HAWKENS: Please complete your thought.

MR. RUMELT: We've heard several times that salinity management is progressing as planned. Well, that's very much contrary to what's in the DSEIS. The DSEIS says that the model is predicted that salinity would reach 34 PSU within a year of beginning those efforts. So, you know, I'm not sure what other plan there is, but the plan that's stated in the DSEIS is less than a year we'll get there. So in terms of progressing as planned, it seems that the answer is, no, they're not progressing as planned.

JUDGE HAWKENS: I don't think that's exactly accurate. Again, Mr. O'Neill said it's not until May 2021 for that 34 PSU to be achieved.

MR. RUMELT: That, Your Honor --

JUDGE HAWKENS: That's the modeling aspect of it, as opposed to they were saying, well, perhaps in a year.

MR. RUMELT: There's certainly a deadline for achieving the goal, and that's not what I'm referring to. I'm referring to the understanding that when they did the modeling and made the decisions to engage in this salinity management effort, the model said less than a year. And that's the progress that everybody expected initially and that hasn't come to fruition. I fully, you know, I agree that they have additional time. I'm not disputing that. But as planned and as forecast by the models, and these were the decision documents that everyone relied on to determine what to do, the forecast was less than a year.

MR. O'NEILL: Can I respond, Your Honor?

JUDGE HAWKENS: I'd like to hear your response, yes. I was about to ask Mr. Turk to respond, but, since you volunteered, I will allow you and then allow to Mr. Turk to supplement, if he wishes.

MR. O'NEILL: I appreciate that, but I think the big problem here stems from the fact that Mr. Rumelt is focused on a model that has essentially been outdated or superseded. I mean, it's the same underlying water and salt balance model. But as I tried to explain before, the discussion of DSEIS on page 349 refers that the Tetra Tech 2014 A memo, and, again, that's when the model was in its kind of embryonic stages, if you will, and it was based on about two years, actually about 22 months of data, and one of those years was particularly wet and that kind of skewed the initial simulations.

Since that time, FPL or Tetra Tech have updated the model to incorporate a lot more weather data. And, again, I mentioned a stochastic model. And so it provides a much, encompasses a much broader range of hydrologic conditions, including drier conditions. And based on that refined model, FPL determined that a longer period of time, the four-year period that's reflected in the consent order, would be needed to reduce the average annual salinity to 34 PSU. And FPL actually explained this in a comment on the draft SEIS. The accession number for FPL's comments are ML 19141A047. That's a matter of public record.

But, again, I had to kind of dispel any notion that that specific model, the 2014 one, really is still even relevant. Again, the model has been subsequently updated and recalibrated. And, again, based on that, that's where the four-year period came from and that's reflected in the consent order.

JUDGE HAWKENS: We'll give you the final word, Mr. Rumelt, in just a second. I want to give Mr. Turk the opportunity to weigh in.

MR. TURK: Your Honor, I would only note that the prediction for the DSEIS is not what are the current conditions and is the model showing that things will be fine in one year or two years or four years. We're looking at the subsequent license renewal period 13 years from now, and our conclusion, based on all of the evidence and the predictive modeling that's occurred, as well as the continued state and county oversight, is that, by the time we get to SLR, the impacts will be as described in the DSEIS. Small.

JUDGE KENNEDY: Again, when you talk about that modeling, is that different than the 26 -- again, I get 2014 and 20 -- what you've described on 349 in the DSEIS, is there a different model that you're referring to now than that model? Because we're back to why you have such confidence that these targets are going to be met.

MR. TURK: Just one moment, Your Honor.

JUDGE KENNEDY: Sure.

MR. TURK: Your Honor, I think the confusion is that there are two different models that we're talking about. At page 3-49, there's the description of the 2014 Tetra Tech model that was used to estimate the freshening that would be required. In Section 4.5.1.2, there's a different model that's discussed, and that's the predictive modeling about the, the predictive modeling done by Tetra Tech regarding the pulling back of the hypersaline plume. That's a 2016 model, so that's different from the model that's being discussed on page 3-49.

JUDGE KENNEDY: There is a connection between the salinity and the CCS and the remediation of the plume. Does the 2016 model include updated information on the salinity level in the CCS when you did a predictive estimate of the remediation of the plume? I can understand why I'm confused.

MR. TURK: Just one moment, Your Honor.

I don't know the answer as we sit here today, Your Honor. Perhaps FPL knows the answer.

MR. O'NEILL: Yes, Your Honor, I guess I tried to explain it before, but I understand that the salinity level of the CCS is accounted for in the, you know, the plume retraction model. We'll call it that. It's --

JUDGE KENNEDY: The 2016 model?

MR. O'NEILL: That is maybe -- I know 2016, I know they also did some sensitivity studies in the 2018 time frame, too, but 2016, yes. And from talking to our technical folks, my understanding is that, you know, the model does assume 34 PSU. Now, getting into new and amended information, and counsel may object, but my understanding is, since we've seen the system has been operating since, I guess it was May of 2018, and FPL just prepared its first annual monitoring report that actually addresses the progress that's seen and it is indicating a very significant hydraulic barrier being created by the ten-well recovery system. In other words, whether it's 34 or 51, you know, the kind of the salinity of the system now, it doesn't matter because the wells are being that effective in preventing the plume from moving further, further west.

JUDGE HAWKENS: Is this hydraulic barrier, is that discussed in the DSEIS?

MR. O'NEILL: Well, certainly, the recovery well system is discussed at length. I mean, I'm kind of using the term hydraulic barrier. It's essentially you're creating a --

JUDGE HAWKENS: Right. That makes sense to me. I just don't recall seeing that term in the DSEIS.

MR. O'NEILL: No, no, no, I think it is -- but the wells are, I think, Figure 3-14 of the DSEIS, actually. So is the location of the ten recovery wells, yes, and discusses the amount of water that they're actually withdrawing from the ground and where it's coming from and, you know, the reviews that the various agencies did.

JUDGE HAWKENS: So your position, Mr. O'Neill, would be that the fact that the model regarding the retraction of the plume has an input of 34 PSU, which is inaccurate and has no material impact on the reasonableness of the models and the accuracy of the models?

MR. O'NEILL: Yes, although I wouldn't necessary consider it to be inaccurate. I mean, again, you know, the ultimate goal is within several years to have, you know, the PSU approaching 34 PSU. And then, of course, the groundwater extraction system, that time line is ten years in terms of the plume retraction. And, again, I think, ultimately, from our perspective, we have to kind of look at reality, what is the system itself doing. Again, the model is a useful tool. I mean, it can kind of help FPL and the regulators understand, you know, what factors are most heavily influencing the movement of the plume, you know, but --

JUDGE HAWKENS: Which we knew is the salinity of the --

MR. O'NEILL: Well, actually, that is one clarification I do want to make. I know --

JUDGE HAWKENS: Well, that's what the DSEIS says.

MR. O'NEILL: Yes, although it refers to the movement, it's the largest contributing factor of the movement of the saltwater interface and there is a distinction between that and the hypersaline plume. The saltwater interface is basically where the water has a salinity of 34 PSU, you know, like ocean water, and that is affected by other factors. Certainly, the plume itself, you know, affects the saltwater interface movement and, of course, if you're retracting that, it's going to affect the movement of the saltwater interface. But there's other kind of regional processes that affect that, as well. I just wanted to make that clarification.

JUDGE HAWKENS: Thank you for your patience, Mr. Rumelt. You have the podium again.

MR. RUMELT: I object.

(Laughter.)

MR. RUMELT: I think it's fairly obvious that we would strenuously object to the introduction of new information.

JUDGE HAWKENS: I've heard that objection earlier, so I understand what you're saying.

MR. RUMELT: Maybe we can make a deal. But, I mean, I think we fleshed out, to an extent, a lot of the facts here. The modeling of the hypersaline plume was based on 34 PSU in the cooling canal, which is not accurate. You know, the only predictive modeling for the salinity in the cooling canal system is the 2014 Tetra Tech analysis. There may have been other, you know, they may have looked at the model to see whether or not it's accurate and, you know, looked at how it's performing. But as far as I know and based on our review of the DSEIS, there's no other prediction of when the cooling canal system salinities will reach 34 PSU. The only one I'm aware of and our modeling expert was aware of was in 2014. And I have nothing further.

JUDGE HAWKENS: Thank you.

JUDGE KENNEDY: Mr. Turk, this morning you pointed us to five Tetra Tech reports that's referenced in the SEIS, draft SEIS. I guess what we're understanding now is these models have different applications, so, for example, the 2014 may be applicable to the salinity content of the CCS and the 2016 model may be relevant to the remediation of the plume. Is there any place where all of this modeling is drawn together in the SEIS to support both conclusions, or are we stuck with -- and what do I do with the other three Tetra Tech reports? What do I --

MR. TURK: Well, Your Honor, they're all referenced in the body of the draft SEIS.

JUDGE KENNEDY: At various places.

MR. TURK: Yes. So each of these references is designated with a unique number. For instance, the 2014 report, there are two reports. One is designated 2014 A, which is a technical memorandum dated May 9, 2014 regarding evaluation of required Floridan water for salinity reduction in the CCS. 2014 B is evaluation of the draw down in the upper

Floridan Aquifer due to proposed salinity reduction-based withdrawals. I think it's probably the 2014 B report that is discussed in the DSEIS, but I'd have to look there to verify. Mr. Folk is nodding his agreement.

So in the DSEIS, when you see a Tetra Tech report referenced, they'll give you that unique designation. You can go to page 6-31 and see which of those reports it is, and then you can go to the ML number that's listed for that report and find the details.

JUDGE KENNEDY: So by tracing the references, I can understand the context in which each of the reports are used?

MR. TURK: Yes.

JUDGE KENNEDY: Okay. That's really what I would, that's a better way to say it.

MR. TURK: Thank you.

MR. O'NEILL: Your Honor, I would confirm that I actually did go to some of those references and was able to pull reports through the state's website. The ones that didn't have accession numbers, they were accessible through a portal. I can't recall right now if it was South Florida Water Management District or the FDEP, but I was able to pull the reports.

ORAL ARGUMENT NOT YET SCHEDULED

No. 20-1026

**IN THE UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT**

FRIENDS OF THE EARTH, NATURAL RESOURCES DEFENSE COUNCIL, INC., AND MIAMI WATERKEEPER,
Petitioners,

v.

UNITED STATES NUCLEAR REGULATORY COMMISSION AND UNITED STATES OF AMERICA,
Respondents.

Petition for Review of a Final Order of the
United States Nuclear Regulatory Commission

**DEFERRED JOINT APPENDIX
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EXECUTIVE SUMMARY

Background

By letter dated January 30, 2018, Florida Power & Light Company (FPL) submitted to the U.S. Nuclear Regulatory Commission (NRC) an application requesting subsequent license renewal for the Turkey Point Nuclear Generating Unit Nos. 3 and 4 renewed facility operating licenses (Agencywide Documents Access and Management System (ADAMS) Package Accession No. ML18037A812). FPL subsequently supplemented its application by letters dated February 9, 2018 (ADAMS Accession No. ML18044A653), February 16, 2018 (ADAMS Package Accession No. ML18053A123), March 1, 2018 (ADAMS Package Accession No. ML18072A224), and April 10, 2018 (ADAMS Package Accession No. ML18113A132). The Turkey Point Unit No. 3 current renewed facility operating license (DPR-31) expires at midnight on July 19, 2032; the Turkey Point Unit No. 4 current renewed facility operating license (DPR-41) expires at midnight on April 10, 2033. In its application, FPL requested license renewal for a period of 20 years beyond the dates when the current renewed facility operating licenses expire, to July 19, 2052 for Turkey Point Unit No. 3 and April 10, 2053 for Turkey Point Unit No. 4.

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 51.20(b)(2), the renewal of a power reactor operating license requires preparation of an environmental impact statement (EIS) or a supplement to an existing EIS. In addition, 10 CFR 51.95(c), "Operating License Renewal Stage," states that, in connection with the renewal of an operating license, the NRC shall prepare an EIS, which is a supplement to the Commission's NUREG–1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants."

Once the NRC officially accepted FPL's application, the NRC staff began the environmental review process as described in 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." The environmental review begins by the NRC publishing a notice of intent in the *Federal Register* to prepare a supplemental environmental impact statement (SEIS) and to conduct environmental scoping. To prepare the Turkey Point SEIS, the NRC staff performed the following:

- conducted two public scoping meetings on May 31, 2018, near the Turkey Point site in Homestead, FL
- conducted a severe accident mitigation alternatives in-office audit in Rockville, MD, from July 5 to July 13, 2018, and an onsite environmental audit at Turkey Point from June 19 to July 22, 2018
- reviewed FPL's environmental report (ER) and compared it to NUREG–1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (the GEIS)
- consulted with Federal, State, Tribal, and local government agencies

- conducted a review of the issues following the guidance set forth in NUREG–1555, Supplement 1, Revision 1, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal," Final Report
- published a draft SEIS for public comment on April 4, 2019, as noticed in the *Federal Register* (84 FR 13322). The draft SEIS was available for public comment through May 20, 2019
- considered public comments received during the scoping process
- considered public comments received on the draft SEIS

Proposed Action

FPL initiated the proposed Federal action (i.e., issuance of renewed facility operating licenses) by submitting an application for subsequent license renewal of Turkey Point. The existing Turkey Point renewed facility operating licenses expire at midnight on July 19, 2032, for Unit No. 3 (DPR-31) and April 10, 2033, for Unit No. 4 (DPR-41). The NRC's Federal action is to decide whether to issue renewed licenses authorizing an additional 20 years of operation. If the NRC issues the renewed licenses, Turkey Point Unit Nos. 3 and 4 would be authorized to operate until July 19, 2052 and April 10, 2053, respectively. The regulation at 10 CFR 2.109, "Effect of Timely Renewal Application," states that if a licensee of a nuclear power plant files an application for renewal of an operating license at least 5 years before the expiration of the existing license, the existing license will not be deemed to have expired until the NRC staff completes its safety and environmental reviews of the application, and the NRC makes a final decision on whether to issue a renewed license for the additional 20 years.

Purpose and Need for Proposed Action

The purpose and need for the proposed action (i.e., issuance of renewed licenses) is to provide an option that allows for power generation capability beyond the term of the current nuclear power plant operating licenses to meet future system generating needs. Energy-planning decisionmakers such as States, utility operators, and, where authorized, Federal agencies (other than the NRC) may determine these future system generating needs. The Atomic Energy Act of 1954, as amended, and the National Environmental Policy Act of 1969, as amended, require the NRC to perform a safety review and an environmental review of the proposed action. The above definition of purpose and need reflects the NRC's recognition that, unless there are findings in the safety review or in the environmental review that would lead the NRC to reject a license renewal application, the NRC does not have a role in the energy-planning decisions as to whether a particular nuclear power plant should continue to operate.

Environmental Impacts of License Renewal

This SEIS evaluates the potential environmental impacts of the proposed action. The NRC designates the environmental impacts from the proposed action as SMALL, MODERATE, or LARGE. NUREG–1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (the GEIS), evaluates 78 environmental issues related to plant operation and classifies each issue as either a Category 1 issue (generic to all or a distinct subset of nuclear power plants) or a Category 2 issue (specific to individual power plants). Category 1 issues are those that meet all the following criteria:

- The environmental impacts associated with the issue apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.
- A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal.
- Mitigation of adverse impacts associated with the issue is considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

SMALL: Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
MODERATE: Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
LARGE: Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

For Category 1 issues, no additional site-specific analysis is required in this SEIS unless new and significant information is identified. As discussed below, the NRC staff did not identify any information that is both new and significant during its review of Florida Power & Light Company's (FPL's) environmental report, the site audits, the scoping period, or its review of public comments on the draft SEIS, that would change the conclusions in the GEIS. Therefore, there are no impacts related to these Category 1 issues beyond those already discussed in the GEIS.

Category 2 issues are site-specific issues that do not meet one or more of the criteria for Category 1 issues; therefore, a SEIS must include additional site-specific review for these non-generic issues. In this SEIS, the NRC staff evaluated Category 2 issues applicable to Turkey Point, as well as cumulative impacts and considered new information regarding severe accident mitigation alternatives (SAMAs).

The NRC staff identified and evaluated new and potentially significant information for two existing Category 1 issues (i.e., groundwater quality degradation (plants with cooling ponds in salt marshes) and cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds)). In addition, the NRC staff identified and evaluated one new issue not categorized as Category 1 or 2 (i.e., water quality impacts on adjacent water bodies (plants with cooling ponds in salt marshes)). As described in Chapter 4 of this SEIS, the impacts of each of these issues is SMALL. Chapter 4 also presents the process for identifying new and significant information.

Table ES-1 summarizes the Category 2 issues relevant to Turkey Point and the NRC staff's findings related to those issues. If the NRC staff determined that there were no Category 2 issues applicable for a particular resource area, the findings of the GEIS, as documented in Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of 10 CFR Part 51, are incorporated for that resource area.

Table ES-1 Summary of NRC Conclusions Relating to Site-Specific Impacts of Subsequent License Renewal at Turkey Point

Resource Area	Relevant Category 2 Issues	Impacts
Groundwater Resources	- Groundwater use conflicts (plants that withdraw more than 100 gallons per minute) - Radionuclides released to groundwater	SMALL to MODERATE SMALL
Terrestrial Resources	- Effects on terrestrial resources (non-cooling system impacts)	SMALL
Aquatic Resources	- Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds) - Thermal impacts on aquatic organisms (plants with once-through cooling systems or cooling ponds)	SMALL to MODERATE SMALL to MODERATE
Special Status Species and Habitats	- Threatened, endangered, and protected species and essential fish habitat	Likely to adversely affect the American crocodile and eastern indigo snake[(a)] May affect, but is not likely to adversely affect or no effect to all other species May result in adverse modification to American crocodile critical habitat[(a)] No adverse modification to West Indian manatee critical habitat No adverse effects on Essential Fish Habitat No effects to sanctuary resources of the Florida Keys National Marine Sanctuary
Historic and Cultural Resources	- Historic and cultural resources	Would not adversely affect known historic properties or historic and cultural resources
Human Health	- Electric shock hazards	SMALL
Environmental Justice	- Minority and low-income populations	No disproportionately high and adverse human health and environmental effects
Cumulative Impacts	- Cumulative Impacts	See SEIS Section 4.16

[(a)] This table summarizes the NRC staff's conclusions regarding special status species and habitats. Separately, in a July 25, 2019, biological opinion, the FWS concluded that the continued operation of Turkey Point through the duration of the proposed subsequent license renewal period is not likely to jeopardize the continued existence of the American crocodile or eastern indigo snake and will not adversely modify the critical habitat of the American crocodile.

Alternatives

As part of its environmental review, the NRC is required to consider alternatives to license renewal and to evaluate the environmental impacts associated with each alternative. These alternatives can include other methods of power generation (replacement power alternatives), as well as not renewing the Turkey Point operating licenses (the no-action alternative).

In total, the NRC staff initially considered 16 replacement power alternatives; the NRC staff later dismissed 13 of these because of technical, resource availability, or commercial limitations that currently exist and that the NRC staff believes are likely to still exist when the current Turkey Point licenses expire.

This left three feasible and commercially viable replacement power alternatives which, in addition to the no-action alternative, the staff evaluates in depth in this report:

- new nuclear power
- natural gas combined-cycle
- combination alternative: natural gas combined-cycle and solar photovoltaic (PV)

These are the 13 additional alternatives that the NRC staff considered but ultimately dismissed:

- solar power
- wind power
- biomass power
- demand-side management
- hydroelectric power
- geothermal power
- wave and ocean energy
- municipal solid waste
- petroleum-fired power
- coal (integrated gasification combined-cycle)
- fuel cells
- purchased power
- delayed retirement of nearby generating facilities

The NRC staff evaluated the environmental impacts of each replacement power alternative, using the same resource areas that it used in evaluating the impacts from subsequent license renewal. In addition, this SEIS evaluates the environmental impacts of an alternative cooling water system, which might be used to mitigate potential impacts associated with the continued use of the existing cooling canal system. Finally, this SEIS evaluates any new and significant information that could alter the conclusions of the SAMA analysis that was performed previously, in connection with the initial license renewal of Turkey Point Unit Nos. 3 and 4.

Recommendation

The NRC staff's recommendation is that the adverse environmental impacts of subsequent license renewal for Turkey Point are not so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable. The NRC staff based its recommendation on the following:

- the analysis and findings in NUREG–1437, “Generic Environmental Impact Statement for License Renewal of Nuclear Plants”
- the environmental report submitted by FPL
- the NRC staff’s consultation with Federal, State, Tribal, and local government agencies
- the NRC staff’s independent environmental review
- the NRC staff’s consideration of public comments received during the scoping process
- the NRC staff’s consideration of public comments received on the draft SEIS

1 INTRODUCTION

The U.S. Nuclear Regulatory Commission's (NRC's) environmental protection regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," implement the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 et seq.). This Act is commonly referred to as NEPA. The regulations at 10 CFR Part 51 require the NRC to prepare an environmental impact statement (EIS) before making a decision on whether to issue an operating license or a renewed operating license for a nuclear power plant.

The Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.) (AEA), specifies that licenses for commercial power reactors can be granted for up to 40 years. The initial 40-year licensing period was based on economic and antitrust considerations rather than on technical limitations of the nuclear facility. NRC regulations permit these licenses to be renewed beyond the initial 40-year term for an additional period of time, limited to 20-year increments per renewal, based on the results of an assessment to determine whether the nuclear facility can continue to operate safely during the proposed period of extended operation. There are no limitations in the AEA or NRC regulations restricting the number of times a license may be renewed.

The decision to seek a renewed license rests entirely with nuclear power facility owners and typically is based on the facility's economic viability and the investment necessary to continue to meet NRC safety and environmental requirements. The NRC makes the decision to grant or deny a renewed license based on whether the applicant has demonstrated reasonable assurance that it can meet the environmental and safety requirements in the agency's regulations during the period of extended operation.

1.1 Proposed Federal Action

Florida Power & Light Company (FPL) initiated the proposed Federal action by submitting an application for subsequent license renewal for Turkey Point Nuclear Generating Unit Nos. 3 and 4 (Turkey Point or Turkey Point Units 3 and 4). The current renewed licenses expire at midnight on July 19, 2032, for Unit No. 3 (DPR-31) and at midnight on April 10, 2033, for Unit No. 4 (DPR-41). The NRC's Federal action is to decide whether to issue renewed licenses for an additional 20 years.

1.2 Purpose and Need for the Proposed Federal Action

The purpose and need for the proposed Federal action (issuance of subsequent renewed licenses for Turkey Point Unit Nos. 3 and 4) is to provide an option that allows for power generation capability beyond the term of the current renewed nuclear power plant operating licenses to meet future system generating needs. Such needs may be determined by energy-planning decisionmakers such as State regulators, utility owners, and Federal agencies other than the NRC. This definition of purpose and need reflects the NRC's recognition that, unless there are findings in the NRC's safety review (required by the Atomic Energy Act) or findings in the NRC's environmental analysis (required by NEPA) that would lead the NRC to reject a subsequent license renewal application, the NRC does not have a role in energy-planning decisions as to whether a particular nuclear power plant should continue to operate.

1.3 Major Environmental Review Milestones

FPL submitted an environmental report (ER) (FPL 2018f) as an appendix to its subsequent license renewal application (SLRA) on January 30, 2018 (FPL 2018a). After reviewing the SLRA and environmental report, as supplemented on February 9 (FPL 2018b), February 16 (FPL 2018c), March 1 (FPL 2018d), and April 10, 2018 (FPL 2018e), the NRC staff accepted the application for a detailed technical review on April 26, 2018 (NRC 2018a). On May 2, 2018, the NRC staff published a *Federal Register* notice of acceptability and opportunity for hearing (Volume 83 of the *Federal Register* (FR), page 19304 (83 FR 19304)). On May 22, 2018, the NRC published another notice in the *Federal Register* (83 FR 23726) informing members of the public of the staff's intent to conduct an environmental scoping process, thereby beginning a 30-day scoping comment period.

The NRC staff held two public scoping meetings on May 31, 2018, near the Turkey Point site in Homestead, FL. In January 2019, the NRC issued its "Supplemental Environmental Impact Statement Scoping Process Summary Report, Turkey Point Nuclear Generating Unit Nos. 3 and 4, Miami-Dade County, Florida," which includes the comments received during the scoping process and the NRC staff's responses to those comments (NRC 2019a).

To independently verify information that FPL provided in its environmental report, the NRC staff conducted an onsite audit at Turkey Point in June 2018, and an in-office severe accident mitigation alternatives audit at NRC headquarters in July 2018. In a letter dated July 20, 2018, the staff summarized the onsite audit and listed the attendees (NRC 2018c). In a letter dated August 31, 2018, the staff summarized the in-office severe accident mitigation alternatives audit and listed the attendees (NRC 2018d). During these audits, the NRC staff held meetings with plant personnel, reviewed site-specific documentation, toured the facility, and held a government-to-government meeting hosted by the U.S. National Park Service.

Upon completion of the scoping period and audits, and completion of its review of FPL's environmental report and related documents, the NRC staff compiled its findings in a draft supplemental environmental impact statement (SEIS) issued on March 31, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19078A330) (NRC 2019m), as noticed in the *Federal Register* (84 FR 13322) on April 4, 2019. The NRC staff made the draft SEIS available for public comment through May 20, 2019. Based on the information gathered during the public comment period and any new information received, the NRC staff amended the draft SEIS, as necessary, and published this final SEIS. Changes made to the draft SEIS in response to comments, as well as changes made to include updated information and minor corrective and editorial revisions, are marked with a change bar (vertical line) on the side margin of the page where the changes were made. Figure 1-1 shows the major milestones of the environmental review portion of the NRC's subsequent license renewal application review process.

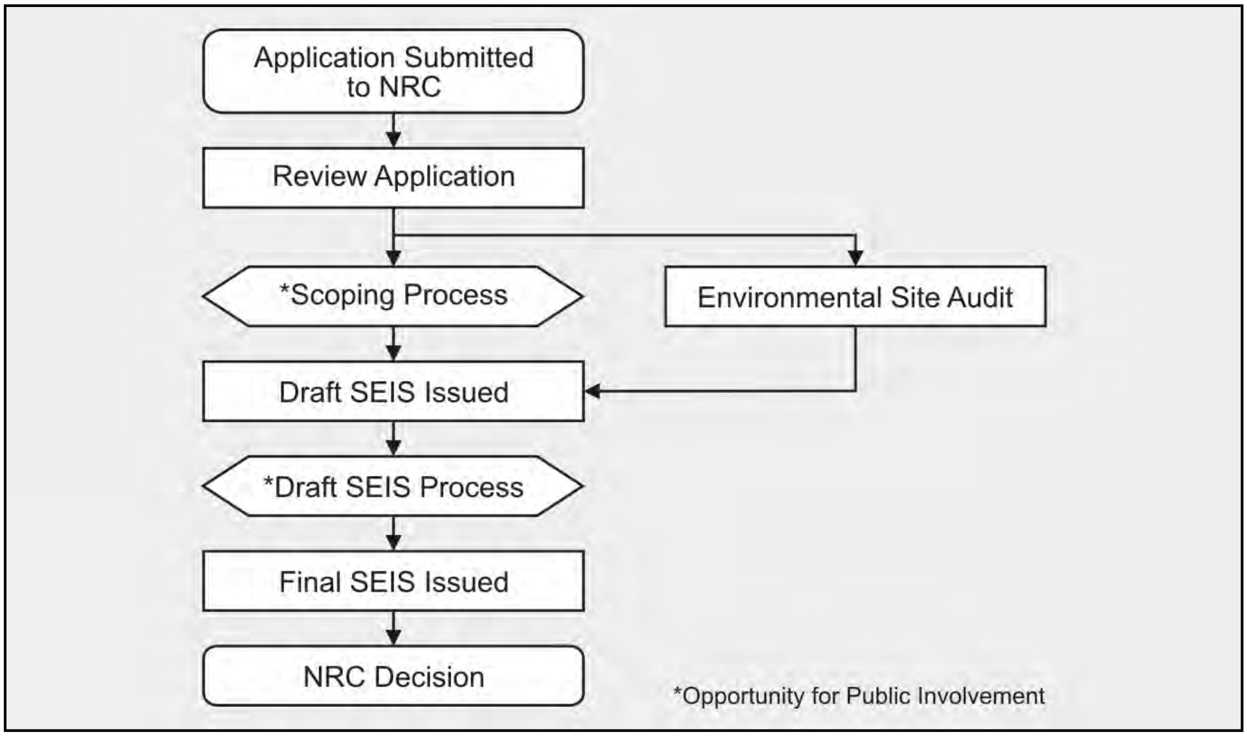


Figure 1-1 Environmental Review Process

The NRC has established a license renewal process that can be completed in a reasonable period of time and that includes clear requirements to assure safe plant operation for up to an additional 20 years of plant life. This process consists of separate environmental and safety reviews, which the NRC staff conducts simultaneously and documents in two reports: (1) the SEIS documents the environmental review and (2) the safety evaluation report (SER) documents the safety review. The staff's findings in the SEIS and the SER are both factors in the NRC's decision to grant or deny the issuance of a renewed license. This process is used for both initial and subsequent license renewal.

1.4 Generic Environmental Impact Statement

To improve the efficiency of its license renewal review process, the NRC staff performed a generic assessment of the environmental impacts associated with license renewal. NUREG–1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants" (known as the GEIS) (NRC 1996, NRC 1999, NRC 2013a), documents the results of the NRC's systematic approach to evaluating the environmental consequences of renewing the licenses of individual nuclear power plants and operating them for an additional 20 years. In the GEIS, the staff analyzed in detail and resolved those environmental issues that could be resolved generically. The NRC issued the GEIS in 1996 (NRC 1996), Addendum 1 to the GEIS in 1999 (NRC 1999), and Revision 1 to the GEIS in 2013 (NRC 2013a). Unless otherwise noted, all references to the GEIS include the original 1996 GEIS, Addendum 1, and the 2013 revision. The conclusions in the GEIS apply to both initial and subsequent license renewal.

The GEIS establishes separate environmental impact issues for the NRC staff to independently evaluate. Appendix B to Subpart A of 10 CFR Part 51, "Environmental Effect of Renewing the

Operating License of a Nuclear Power Plant," provides a summary of the staff's findings in the GEIS. For each environmental issue addressed in the GEIS, the NRC staff:

- describes the activity that affects the environment
- identifies the population or resource that is affected
- assesses the nature and magnitude of the impact on the affected population or resource
- characterizes the significance of the effect for both beneficial and adverse effects
- determines whether the results of the analysis apply to all plants
- considers whether additional mitigation measures would be warranted for impacts that would have the same significance level for all plants

The NRC established its standard of significance for impacts using the Council on Environmental Quality terminology for "significant." The NRC established three levels of significance for potential impacts—SMALL, MODERATE, and LARGE—as defined below.

SMALL: Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

MODERATE: Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

LARGE: Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

Significance indicates the importance of likely environmental impacts and is determined by considering two variables: **context** and **intensity**.

Context is the geographic, biophysical, and social context in which the effects will occur.

Intensity refers to the severity of the impact in whatever context it occurs.

The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants (or a distinct subset of plants, as defined in the GEIS) and whether additional mitigation measures would be warranted. Issues are assigned a Category 1 (generic to all or a subset of plants) or Category 2 (site-specific) designation. As established in the GEIS, Category 1 issues are those that meet the following three criteria:

- The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants that have a specific type of cooling system or other specified plant or site characteristics.
- A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).
- Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For generic issues (Category 1), the SEIS requires no additional site-specific evaluation unless new and significant information has been identified. Chapter 4 of this report describes the process for identifying new and significant information for site-specific analysis. Site-specific issues (Category 2) are those that do not meet the three criteria of Category 1 issues; therefore, the GEIS requires additional site-specific review for these issues.

The 2013 GEIS evaluates 78 environmental issues, provides generically applicable findings for numerous issues (subject to the consideration of any new and significant information on a site-specific basis), and concludes that a site-specific analysis is required for 17 of the 78 issues. Figure 1-2 illustrates the license renewal environmental review process. The results of that site-specific review are documented in the SEIS.

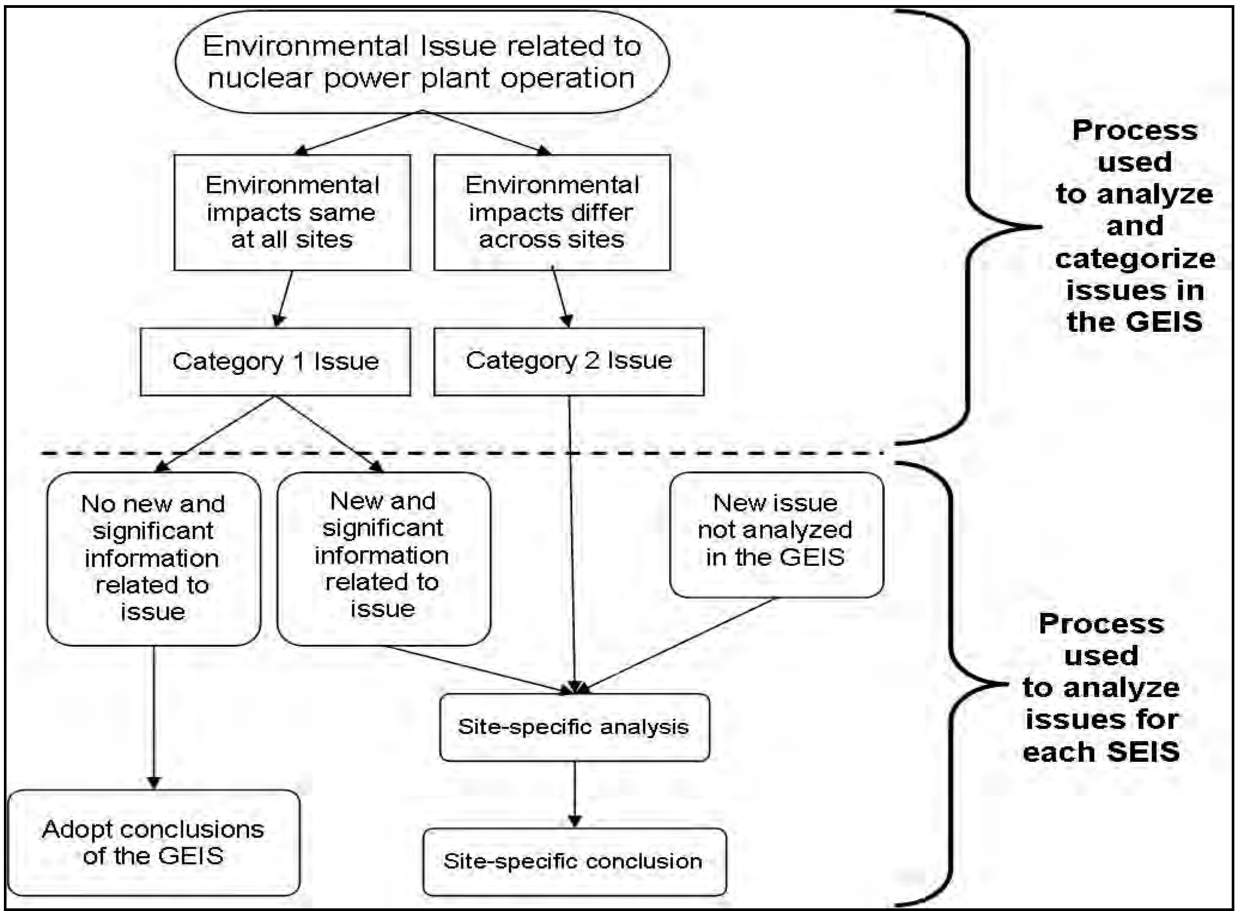


Figure 1-2 Environmental Issues Evaluated for License Renewal

1.5 Supplemental Environmental Impact Statement

This SEIS presents the NRC staff's final analysis of the environmental effects of the continued operation of Turkey Point through the subsequent license renewal period, alternatives to subsequent license renewal, and mitigation measures for minimizing adverse environmental impacts. Chapter 4, "Environmental Consequences and Mitigating Actions," contains an analysis and comparison of the potential environmental impacts from subsequent license renewal and alternatives to subsequent license renewal. Chapter 5, "Conclusion," presents the NRC's recommendation on whether the environmental impacts of subsequent license renewal are so great that preserving the option of subsequent license renewal would be unreasonable. In issuing the final SEIS, the NRC staff considered the comments it had received on the previously published draft SEIS. The NRC staff will make its final recommendation to the Commission on Turkey Point Units 3 and 4 subsequent license renewal in the record of decision to be issued following issuance of this final SEIS.

In the preparation of the Turkey Point SEIS, the NRC staff carried out the following activities:

- reviewed the information provided in FPL's environmental report
- consulted with Federal, State, Tribal, and local government agencies
- conducted an independent environmental review, including the environmental and severe accident mitigation analysis site audits
- considered public comments received during the scoping process
- considered public comments received on the draft SEIS

New and significant information. To merit additional review, information must be both new and significant and it must bear on the proposed action or its impacts.

New information can come from many sources, including the applicant, the NRC, other agencies, or public comments. If the information reveals a new issue, the staff will first analyze the issue to determine whether it is within the scope of the license renewal environmental evaluation. If the staff determines that the new issue bears on the proposed action, the staff will then determine the significance of the issue for the plant and analyze the issue in the SEIS, as appropriate.

1.6 Decisions To Be Supported by the SEIS

This SEIS supports the NRC's decision on whether to issue renewed operating licenses for Turkey Point for an additional 20 years. The regulation at 10 CFR 51.103(a)(5) specifies the NRC's decision standard as follows:

> In making a final decision on a license renewal action pursuant to Part 54 of this chapter [10 CFR], the Commission shall determine whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable.

There are many factors that the NRC takes into consideration when deciding whether to renew the operating license of a nuclear power plant. The analyses of environmental impacts in this SEIS will provide the NRC's decisionmaker (in this case, the Commission) with important environmental information for use in the overall decisionmaking process. Other decisions are made outside the regulatory scope of license renewal, by the NRC or other decisionmakers. These include decisions related to: (1) changes to plant cooling systems, (2) disposition of spent nuclear fuel, (3) emergency preparedness, (4) safeguards and security, (5) need for power, and (6) seismicity and flooding (NRC 2013a).

1.7 Cooperating Agencies

The U.S. National Park Service, Southeast Region (NPS), is participating in the environmental review of subsequent license renewal for Turkey Point as a cooperating agency. The NPS does not have any specific regulatory actions related to the proposed subsequent license renewal;

however, NPS is providing special expertise for environmental issues pertaining to the areas in and around Biscayne National Park, which is located next to the Turkey Point site. In a letter dated March 5, 2019, the NPS provided comments to the NRC staff on preliminary sections of the draft SEIS discussing water resources, terrestrial resources, aquatic resources, and special status species and habitats (NPS 2019a). In addition, in a letter dated May 16, 2019, the NPS provided comments on the draft SEIS discussing the geologic environment, surface water, groundwater, terrestrial, and visual resources; cooling and auxiliary water systems; water quality impacts; alternatives; and various sections of the draft SEIS (NPS 2019b).

1.8 Consultations

The Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) (ESA); the Magnuson–Stevens Fishery Conservation and Management Act of 1996, as amended (16 U.S.C. 1801 et seq.) (MSA); and the National Historic Preservation Act of 1966, as amended (54 U.S.C. 300101 et seq.) (NHPA), require Federal agencies to consult with applicable State and Federal agencies and organizations before taking an action that may affect endangered species, fisheries, or historic and archaeological resources, respectively. Additionally, under the National Marine Sanctuaries Act (16 U.S.C. 1431 et seq.) (NMSA), agency actions that are likely to destroy, cause the loss of, or injure any sanctuary resource are subject to consultation with the National Oceanic and Atmospheric Administration (NOAA). The NRC staff consulted with the following agencies and organizations during this environmental review:

- U.S. Fish and Wildlife Service (FWS)
- National Marine Fisheries Service (NMFS)
- Miami-Dade County Office of Historic Preservation
- Miccosukee Tribe of Indians of Florida
- Muscogee (Creek) Nation
- Poarch Band of Creek Indians
- The Seminole Nation of Oklahoma
- Seminole Tribe of Florida
- Florida Department of State, Division of Historical Resources
- Federal Advisory Council on Historic Preservation

In addition, the NRC staff determined that consultation was not warranted with regard to the Florida Keys National Marine Sanctuary (FKNMS) under the National Marine Sanctuaries Act (16 U.S.C. 1431 et seq.) (NMSA). Appendix C, "Consultation Correspondence," of this SEIS discusses the consultations that the NRC staff conducted, or considered to be unwarranted, in support of this environmental review.

In addition, on June 18, 2018, the NRC staff participated in an interagency meeting related to the proposed subsequent license renewal action. Participating Federal, State, and local agencies included the National Park Service (NPS), U.S. Environmental Protection Agency

(EPA), FWS, NOAA, Florida Department of Environmental Protection (FDEP), and Miami-Dade County Division of Environmental Resources Management (DERM). The primary goals of the meeting included the following:

- Provide an overview of NRC's environmental review process related to FPL's application to renew the operating licenses at Turkey Point.
- Gather input from other Federal, State, and local agencies regarding available environmental data and issues.

During the meeting, the NRC staff provided an overview of the subsequent license renewal process, several agencies presented environmental data and issues related to Turkey Point, and lastly, participants held a general discussion related to the environmental review (NRC 2018l). Information provided by the meeting participants has been considered by the NRC staff in preparing this SEIS.

1.9 Correspondence

During the environmental review, the NRC staff contacted Federal, State, regional, local, and Tribal government agencies listed in Section 1.8 above. Appendix C, "Consultation Correspondence," describes correspondence between the NRC staff, the FWS, the NMFS, and Indian tribes associated with the ESA, the MSA, and the NHPA. Appendix D, "Chronology of Environmental Review Correspondence," chronologically lists all other correspondence.

1.10 Status of Compliance

FPL is responsible for complying with all NRC regulations and other applicable Federal, State, and local requirements. Appendix F of the GEIS describes some of the major applicable Federal statutes. Numerous permits and licenses are issued by Federal, State, and local authorities for activities at Turkey Point. Appendix B of this SEIS contains further information about FPL's status of compliance.

1.11 Related State and Federal Activities

The NRC reviewed the possibility that activities of other Federal agencies might affect the renewal of the operating licenses for Turkey Point. There are no Federal projects that would make it necessary for another Federal agency to become a cooperating agency in the preparation of this SEIS.

Two Indian reservations, the Miccosukee Indian Reservation (approximately 47 miles (75 km) northwest of Turkey Point) and the Seminole Tribe of Florida, Hollywood Reservation (approximately 43 mi (68 km) north of Turkey Point), are located with 50 miles (80 km) of Turkey Point. The area surrounding the Turkey Point site is low, swampy, and sparsely populated. The Turkey Point site is adjacent to waters and coastal lands that are part of the Biscayne National Park and is within 2 miles (3.2 km) of the Model Lands Basin, a South Florida Water Management District conservation area. A portion of the Biscayne Bay Aquatic Preserve is located immediately east of the Turkey Point site, and a separate portion of the preserve, along with the Florida Keys National Marine Sanctuary, is located adjacent to the south-southeastern border of the Turkey Point site boundary. The Turkey Point site is also located just east of the 13,000-acre Everglades Mitigation Bank. The Homestead Bayfront Park, a city park, is located approximately 2 miles (3.2 km) north-northwest of Turkey Point. (FPL 2018f)

Section 102(2)(C) of NEPA requires the NRC to consult with and obtain the comments of any Federal agency that has jurisdiction by law or special expertise with respect to any environmental impact involved in the subject matter of the SEIS. In accordance with this requirement, during the course of preparing the SEIS, the NRC consulted, for example, with the FWS. Appendix D provides a chronology of environmental review correspondence with the FWS and other Federal agencies.

2.2.3 Cooling Water System Alternative

In addition to replacement power alternatives, this SEIS evaluates an alternative cooling water system technology (mechanical draft cooling towers) for Turkey Point Units 3 and 4 that might be used to mitigate the potential impacts associated with continued use of the existing cooling canal system. The purpose of this analysis is for the NRC staff to compare an alternative closed-cycle cooling system approach with the proposed action to inform the NRC's licensing decision, decisions by other decisionmakers and the public, as applicable, under NEPA. However, the NRC has neither the statutory nor the regulatory authority to determine which system or technology should be used, or to decide other permitting issues, for which the State of Florida has been delegated regulatory authority under the Clean Water Act.

The environmental impacts of the alternative cooling water system are described in this SEIS within the discussion of each separate resource area (e.g., Sections 4.2.7, 4.3.7, 4.4.7, 4.5.7, 4.6.7, 4.7.7, 4.9.4, 4.10.7, 4.11.7, 4.12.4, and 4.13.7). The benefits of the alternative cooling water system are that the impacts of utilizing the CCS for cooling of Turkey Point Units 3 and 4 would be avoided; those impacts are discussed extensively in this SEIS; the avoidance of those impacts of CCS operation (e.g., on groundwater resources), is discussed in Section 4.5.2 (Water Resources: "No-Action Alternative"), in that use of the CCS to cool Units 3 and 4 would cease at the end of the current license terms if the Turkey Point subsequent license renewal (SLR) application is denied.

The NRC staff's analysis of the alternative cooling water system draws upon an application which FPL submitted to the NRC in 2009, for COLs to build and operate two new onsite nuclear reactors (Turkey Point Units 6 and 7). The NRC staff conducted an environmental review of that COL application and published it as NUREG–2176. Section 3.2.2.2 of the COL EIS describes a cooling water system alternative to Turkey Point's existing cooling canal system that consists of onsite mechanical draft cooling towers (NRC 2016a). Under the cooling water system alternative that is evaluated by the NRC staff in this license renewal SEIS, Turkey Point Units 3 and 4 would each use three similar closed-cycle wet-cooling towers (six cooling towers in total) to dissipate heat from the reactor cooling water systems. These mechanical draft water towers would be octagonal in shape and extend approximately 70 feet (20 m) in height and 250 feet (75 m) in diameter (NRC 2016a).

The Units 3 and 4 cooling towers would have the same general design, construction, and operating characteristics as the cooling water system associated with the new nuclear alternative described in Section 2.2.2.1 of this SEIS, although additional engineering complexities and costs could be associated with detailed designs for retrofitting Turkey Point's cooling water system in this manner. As in the new nuclear alternative, the primary source of cooling water is assumed to be reclaimed wastewater. Similarly, as summarized in Table 2-1 of this SEIS, cooling water makeup would be approximately 38 mgd (144,000 m^3/day) and consumptive water use would be approximately 29 mgd (110,000 m^3/day). Other discrete resource requirements associated with constructing and operating these cooling towers would be a subset of the overall resource requirements identified in NUREG–2167 (the EIS for the Turkey Point Units 6 and 7 combined licenses) in Tables 3-4 and 3-6 (NRC 2016a).

The CCS would continue to operate regardless of the proposed Turkey Point subsequent license renewal because it supports retired fossil fuel Units 1 and 2. FPL plans to continue to use water from the CCS to support the operation of these units in synchronous condenser mode over the course of the proposed subsequent license renewal period, as described in Section 3.1.3, "Cooling and Auxiliary Water Systems." Additionally, fossil fuel Unit 5 would remain in operation and would continue to discharge blowdown to the CCS. Furthermore, the CCS-related requirements of the October 7, 2015, Consent Agreement between FPL and Miami-Dade County (MDC 2015a) and the June 20, 2016, Consent Order between FPL and the Florida Department of Environmental Protection (FDEP 2016a), both of which are discussed in detail in Section 3.5.1.4, "Adjacent Surface Water Quality and Cooling Canal System Operation," as well as in Section 3.5.2.2, "Groundwater Quality," of this SEIS, would continue to apply.

2.3 Alternatives Considered but Eliminated

The NRC staff originally considered 16 replacement power alternatives to Turkey Point Unit 3 and 4's subsequent license renewal, but ultimately eliminated 13 of these from detailed study. The staff eliminated these 13 alternatives because of technical reasons, resource availability limitations, or commercial or regulatory limitations. Many of these limitations will likely still exist when the current Turkey Point licenses expire in 2032 and 2033, such that these 13 alternatives are not expected to be reasonably available when needed to replace the power generated by Turkey Point Units 3 and 4.

2.3.1 Solar Power

Solar power, including solar photovoltaic (PV) and concentrating solar power (CSP) technologies, produce power generated from sunlight. Solar photovoltaic components convert sunlight directly into electricity using solar cells made from silicon or cadmium telluride. Concentrating solar power uses heat from the sun to boil water and produce steam. The steam then drives a turbine connected to a generator to ultimately produce electricity (NREL 2014).

Solar generators are considered an intermittent resource because their availability depends on ambient exposure to the sun, also known as solar insolation (EIA 2017c). Insolation rates of solar photovoltaic resources in Florida range from 5.0 to 5.5 $kWh/m^2/day$ (NREL 2017a). Due to higher solar insolation requirements associated with concentrating solar power, utility-scale application of this technology has generally only occurred in western States with high solar thermal resources and large, contiguous tracts of land in arid environments (i.e., California, Arizona, and Nevada) (EIA 2016c). The exception is FPL's Martin generating station, the only concentrating solar power plant east of the Rocky Mountains, which produced approximately 22 percent of the state's utility-scale net solar generation in 2016 (EIA 2017d).

Although Florida has abundant solar resource potential, it generates only a small part of its energy from solar or other renewable resources (EIA 2017a). In addition, Florida does not have a mandatory renewable portfolio standard that would require generators to consider solar power (EIA 2017a). To be considered a viable alternative, a solar alternative must replace the amount of electricity that Turkey Point provides. Assuming capacity factors of 25 percent (for solar photovoltaic) to 50 percent (for concentrating solar) (DOE 2011), approximately 3,000 to 6,000 MWe of additional gross solar capacity would need to be installed in locations servicing southeastern Florida. As discussed in Section 2.2.2.3, FPL plans to install approximately 6,900 MW of additional solar photovoltaic generating capacity within the next decade. This increased solar capacity, however, would be used to replace or augment existing capacity and/or meet forecasted demand, and would not be available as a reasonable alternative for replacement of Turkey Point Units 3 and 4 (FPL 2019l). Further, although FPL has announced plans to substantially increase its share of solar photovoltaic generating capacity across its service area over the next decade, the amount of this additional capacity that would be sited in

Table 2-2 Summary of Environmental Impacts of the Proposed Action and Alternatives

Impact Area (Resource)	Turkey Point Subsequent License Renewal (Proposed Action)	No-Action Alternative	New Nuclear Alternative	Natural Gas Combined-Cycle Alternative	Combination Alternative (Natural Gas Combined-Cycle and Solar Photovoltaic)	Cooling Water System Alternative
Land Use	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to LARGE	SMALL
Visual Resources	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to LARGE	SMALL to MODERATE
Air Quality	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL
Noise	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Geologic Environment	SMALL	SMALL	SMALL	SMALL	MODERATE	SMALL
Surface Water Resources	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Groundwater Resources	SMALL to MODERATE	SMALL	SMALL	SMALL	SMALL	SMALL
Terrestrial Resources	SMALL	SMALL	MODERATE	MODERATE	MODERATE	MODERATE
Aquatic Resources	SMALL to MODERATE	SMALL	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE	MODERATE
Special Status Species and Habitats	See Note(a)	See Note(b)	See Note(b)	See Note(b)	See Note(b)	See Note(b)
Historic and Cultural Resources	See Note(c)	See Note(d)	See Note(e)	See Note(e)	See Note(f)	See Note(e)
Socioeconomics	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL	SMALL
Transportation	SMALL	SMALL	SMALL to LARGE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Human Health	SMALL(g)	SMALL(g)	SMALL(g)	SMALL(g)	SMALL(g)	SMALL(g)
Environmental Justice	See Note(h)	See Note(i)	See Note(j)	See Note(j)	See Note(k)	See Note(j)
Waste Management and Pollution Prevention	SMALL(l)	SMALL(l)	SMALL (l)	SMALL	SMALL	SMALL

Impact Area (Resource)	Turkey Point Subsequent License Renewal (Proposed Action)	No-Action Alternative	New Nuclear Alternative	Natural Gas Combined-Cycle Alternative	Combination Alternative (Natural Gas Combined-Cycle and Solar Photovoltaic)	Cooling Water System Alternative

(a) The NRC staff concludes that Turkey Point subsequent license renewal is likely to adversely affect the American crocodile and the eastern indigo snake, and may result in adverse modification to designated critical habitat of the American crocodile. The NRC staff concludes that proposed action may affect, but is not likely to adversely affect, the Florida panther, West Indian manatee, red knot, wood stork, loggerhead sea turtle, green sea turtle, leatherback sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, and smalltooth sawfish. The NRC staff concludes that the proposed action would result in no adverse modification to designated critical habitat of the West Indian manatee. The NRC staff's evaluation of impacts to federally listed species and critical habitats under the U.S. Fish and Wildlife Service's jurisdiction appears in the NRC's Biological Assessment (NRC 2018n). The FWS's separate evaluation and conclusions appear in a July 25, 2019, biological opinion (FWS 2019b), which is described in Section 4.8.1.1 of this SEIS. The NRC staff's evaluation of impacts to federally listed species and critical habitats under the National Marine Fisheries Service's jurisdiction appears in Section 4.8.1.1 of this SEIS. The NRC staff concludes that the proposed action would have no adverse effects on Essential Fish Habitat. The NRC staff's evaluation of impacts to Essential Fish Habitat appears in Section 4.8.1.2 of this SEIS. The NRC staff concludes that the proposed action would not affect the sanctuary resources of the Florida Keys National Marine Sanctuary. The NRC staff's evaluation of sanctuary resources appears in Section 4.8.1.3 of this SEIS.

(b) The types and magnitudes of adverse impacts to species listed pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.), designated critical habitat, and Essential Fish Habitat would depend on Turkey Point shutdown activities, the proposed alternative site, plant design, and operation, as applicable, and on the listed species and designated critical habitats present when the alternative is implemented. Therefore, the NRC staff cannot forecast a particular level of impact for this alternative.

(c) Based on (1) the location of National Register of Historic Places-eligible historic properties within the area of potential effect, (2) tribal input, (3) FPL's cultural resource protection plans, (4) the fact that no license renewal-related physical changes or ground-disturbing activities would occur, (5) Florida State Historic Preservation Office input, and (6) cultural resource assessment, license renewal would not adversely affect any known historic properties (Title 36 of the *Code of Federal Regulations* 800.4(d)(1), "No Historic Properties Affected").

(d) As a result of facility shutdown, land-disturbing activities or dismantlement are not anticipated as these would be conducted during decommissioning. Therefore, facility shutdown would have no immediate effect on historic properties or historic and cultural resources.

(e) Since the alternative would be located at the Turkey Point site, which has a low archeological potential, and avoidance of significant resources would be possible, this alternative would not adversely affect known historic properties.

(f) The impacts from the construction and operation of the solar component would depend on where solar facilities are constructed. The historic and cultural resource impact could range from no adverse effect to adverse effect.

(g) The chronic effects of electromagnetic fields on human health associated with operating nuclear power and other electricity generating plants are uncertain.

(h) There would be no disproportionately high and adverse impacts to minority and low-income populations.

(i) A reduction in tax revenue resulting from the shutdown of Turkey Point could decrease the availability of public services in the Turkey Point area. However, the effects to minority and low-income populations would not be disproportionately high and adverse.

Impact Area (Resource)	Turkey Point Subsequent License Renewal (Proposed Action)	No-Action Alternative	New Nuclear Alternative	Natural Gas Combined-Cycle Alternative	Combination Alternative (Natural Gas Combined-Cycle and Solar Photovoltaic)	Cooling Water System Alternative

(j) Based on the analysis of human health and environmental impacts presented in this SEIS, the location of the alternative, and the assumed alternative design and characteristics, this alternative would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

(k) This alternative would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations. However, this determination would depend on the location of the solar facilities. Therefore, the NRC staff cannot determine whether the solar portion of the combination alternative would result in disproportionately high and adverse human health and environmental effects on minority and low-income populations.

(l) NUREG–2157, “Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel,” (NRC 2014c) discusses the environmental impact of spent fuel storage for the timeframe beyond the licensed life for reactor operations.

3 AFFECTED ENVIRONMENT

In conducting its environmental review of the Turkey Point Nuclear Generating Unit Nos. 3 and 4 (Turkey Point, or Turkey Point Units 3 and 4) subsequent license renewal application, the U.S. Nuclear Regulatory Commission (NRC) first defines and describes the environment that could be affected by the subsequent license renewal. For this review, the NRC staff defines the affected environment as the environment that currently exists at and around the Turkey Point site. Because existing conditions are at least partially the result of past construction and operations at the plant, this chapter presents the nature and impacts of these past actions as well as ongoing actions, and evaluates how, together, these actions have shaped the current environment. The effects of ongoing reactor operations at Turkey Point have become well established as environmental conditions have adjusted to the presence of the nuclear power plant. Sections 3.2 through 3.13 describe the affected environment for each resource area. The resource discussions in this chapter include new and updated information that became available since the NRC issued the supplemental environmental impact statement (SEIS) for the initial Turkey Point license renewal in 2002, as NUREG-1437, Supplement 5 (NRC 2002c).

3.1 Description of Nuclear Power Plant Facility and Operation

The physical presence of Turkey Point buildings and facilities, as well as the plant's operations, are integral to the environment that currently exists at and around the site. This section describes Turkey Point buildings, certain nuclear power plant operating systems, and certain plant infrastructure, operations, and maintenance.

3.1.1 External Appearance and Setting

Turkey Point is located on the southeastern coast of Florida in unincorporated southeastern Miami-Dade County (Figure 3-1). The site borders Biscayne Bay and Card Sound. Turkey Point is approximately 25 miles (mi) (40 kilometers (km)) south-southwest of the city of Miami, which is the largest population center in the region with an estimated population of 424,632. Portions of Homestead Air Reserve Base and the cities of Florida City and Homestead are located within approximately 9 mi (14.5 km) of the Turkey Point site. Miami, Florida City, Homestead, Homestead Air Reserve Base, and Turkey Point are all located in Miami-Dade County, FL. Florida City is located approximately 9 mi (14.5 km) west of Turkey Point and has an estimated population of 12,000. The city of Homestead is located approximately 9 mi (14.5 km) west-northwest of Turkey Point and has an estimated population of 65,000. Homestead Air Reserve Base is located approximately 6 mi (9.7 km) northwest of Turkey Point and has an estimated population of 1,100 (FPL 2018f).

Turkey Point Units 3 and 4 are two pressurized-water nuclear reactors located on approximately 9,460 acres (ac) (38.3 kilometers squared (km^2)) of FPL-owned land. In addition to nuclear generating Units 3 and 4, the Turkey Point site also houses three fossil fuel power plants: Units 1 and 2 are retired, natural-gas/oil steam-generating units; and Unit 5 is an operating, natural-gas combined-cycle steam generating unit. In addition to these five currently operating and retired units, the Turkey Point site also features a 5,900-ac (24 km^2) artificial body of water called the cooling canal system (CCS). This network of canals forms a recirculating source of water that is used by Units 3 and 4 for reactor heat rejection. Unit 5 does not use the cooling canals for heat rejection but does use the CCS for stormwater discharge and cooling water blowdown. The principal structures for Turkey Point Units 3 and 4 are the reactor containments, auxiliary building, control building, turbine building, radioactive waste management building, intake structure, discharge structures, steam generator storage compound, and administration building. The main structures outside the power block are an independent spent fuel storage installation (ISFSI), a sewage treatment plant, a 230-kilovolt (kV) switchyard, a meteorological tower, the cooling water intake canal, the cooling water discharge canal, and the 5,900-ac ($24\ km^2$) network of cooling canals between them (FPL 2018f).

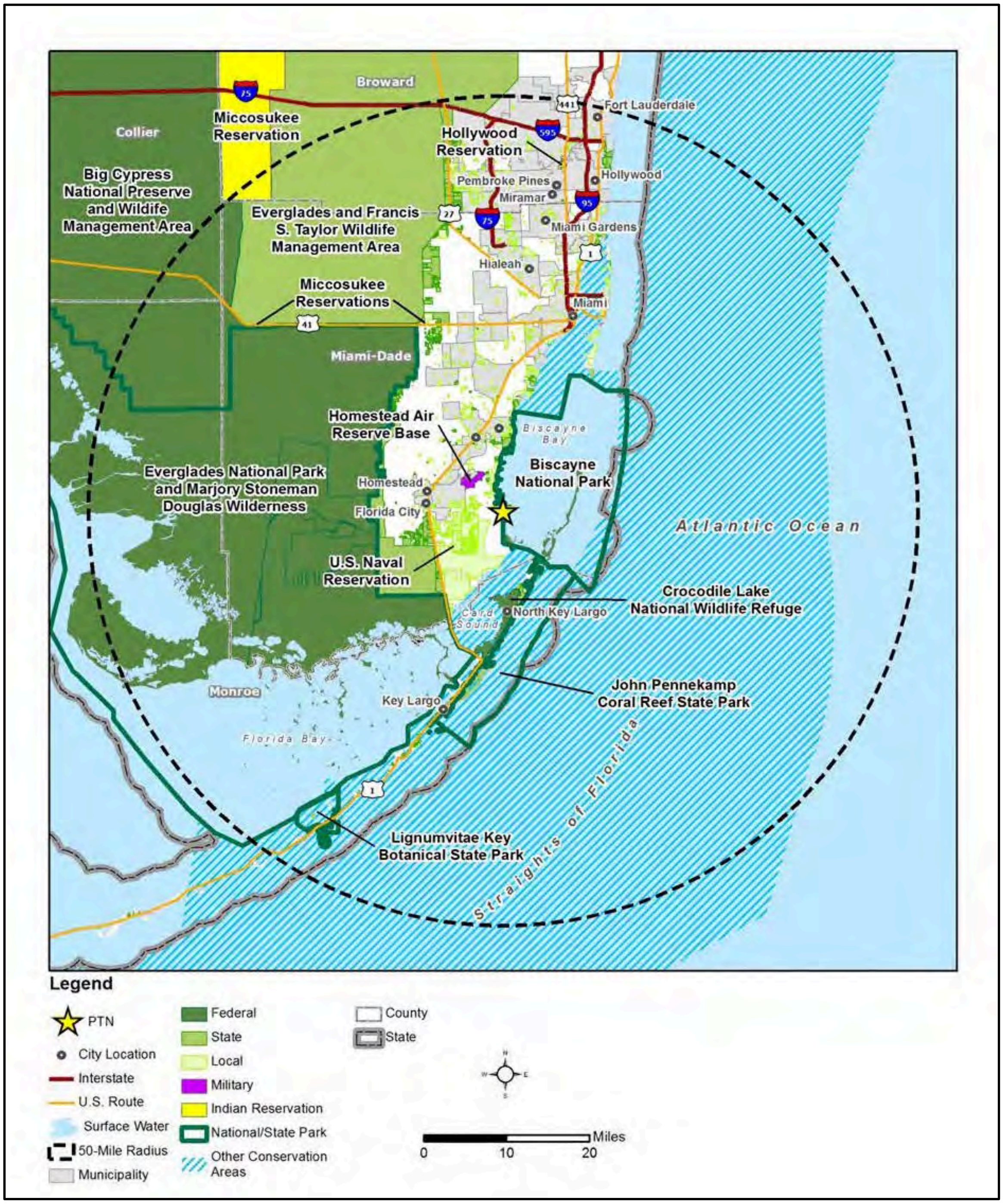


Figure 3-1 Map Showing the 50-mi (80-km) Radius Around the Turkey Point Site (FPL 2018f)

3.1.2 Nuclear Reactor Systems

Turkey Point Units 3 and 4 are Westinghouse, three-loop pressurized-water reactors (PWRs) with dry, ambient pressure containments. The NRC's predecessor agency, the Atomic Energy Commission, issued the Turkey Point Unit 3 facility operating license on July 19, 1972 and the Unit 4 facility operating license on April 10, 1973. Subsequently, on June 6, 2002, the NRC issued renewed facility operating licenses for Turkey Point Units 3 and 4, authorizing an additional 20 years of operation (NRC 2002b). Turkey Point Units 3 and 4 are each rated for a reactor core power level of 2,644 megawatts thermal (MWt) (FPL 2018f). Together, Units 3 and 4 produce a combined total of 1,632 megawatts electric (MWe) (FPL 2018f).

Both the Unit 3 and Unit 4 reactor cores are composed of uranium dioxide pellets enclosed in Zircaloy-4, ZIRLO®, Optimized ZIRLO™ high-performance fuel cladding material tubes with welded end plugs. A spring clip grid structure supports the tubes in assemblies. The mechanical control rods consist of clusters of stainless steel-clad absorber rods and guide tubes located within the fuel assemblies (FPL 2018f).

3.1.3 Cooling and Auxiliary Water Systems

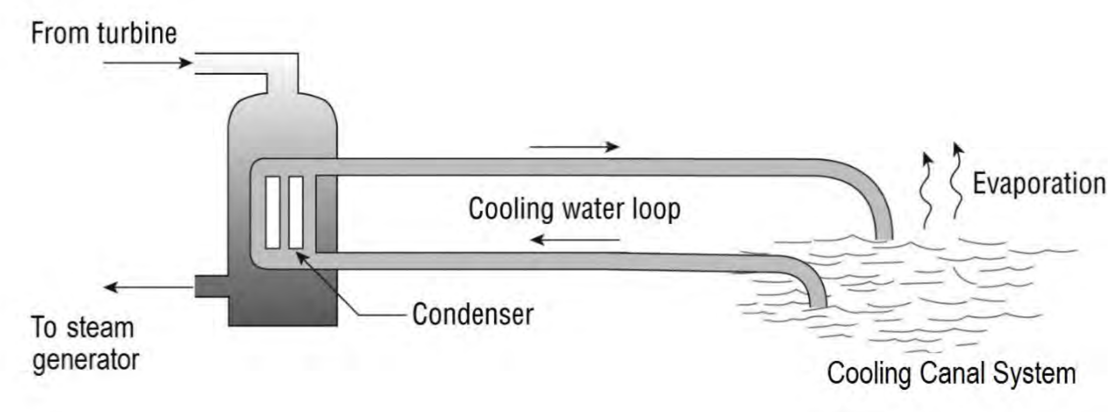
As mentioned earlier, Turkey Point Units 3 and 4 are both PWRs. PWRs heat water under pressure to very high temperatures to create steam. That steam turns the turbines that then generate electricity. PWRs use a closed-cycle cooling system to dissipate the heat in the water. The closed-cycle cooling system uses three heat exchange loops to cool the water: (1) the primary coolant loop, (2) the secondary loop, and (3) the cooling water loop. These are as follows.

Primary Coolant Loop: In the primary coolant loop, water is drawn into the reactor and heated to very high temperatures while under great pressure. The pressure keeps the water from turning into steam. Water in the primary loop that has been heated in the reactor passes through a steam generator where heat is transferred to water in a secondary loop. Once the heat is transferred, the water in the primary coolant loop returns to the reactor to be heated again under high pressure.

Secondary Loop: In the heat transfer process, the water in the primary loop and the water in the secondary loop do not come into contact with each other. In the steam generator, the heated water in the secondary loop is allowed to flash into steam, which is what drives the turbines that in turn produce electricity. The water in the secondary loop (now in steam form), then travels to the condenser where it transfers its heat energy to water in the third loop (called the cooling water loop). When heat is transferred, the water temperature decreases and the steam water in the secondary loop condenses back to liquid water. The liquid water in the secondary loop then returns to the steam generator to be reheated.

Cooling Water Loop: As is the case with the transfer of heat between the primary coolant loop and the secondary loop, in the condenser, the water in the secondary loop and the water in the cooling water loop do not come into contact with one another. From the condenser, water in the cooling water loop (third loop) can either flow to cooling towers (not present for Units 3 and 4) where it is cooled by evaporation or it can be discharged directly to an external body of water (NRC 2013a). Figure 3-2 below shows a simple schematic diagram of a generic PWR cooling system with a cooling canal system. At Turkey Point, water from the cooling water loop is discharged into a body of water called the cooling canal system (CCS).

The sections below describe in greater detail the cooling water loop, the CCS, the auxiliary cooling water system, the fire protection water system, and the potable water system at Turkey Point. Unless otherwise cited herein, the NRC staff drew information about Turkey Point's cooling and auxiliary water systems from the following sources: FPL's environmental report that it submitted as part of the subsequent license renewal application (FPL 2018f), the NRC staff's 2002 SEIS for the initial Turkey Point license renewal published as NUREG–1437, Supplement 5 (NRC 2002c), and the NRC staff's onsite environmental audit at Turkey Point in June 2018.



Source: Modified from NRC 2013a

Figure 3-2 Generic Cooling System with Cooling Canal System

3.1.3.1 General Description of Cooling Water Loop

In a PWR closed-cycle cooling system, the primary function of the third loop—the cooling water loop—is to transport heat from inside the reactor to the outside environment. At Turkey Point, the cooling water loop withdraws water from an artificially constructed body of water called the cooling canal system (CCS) and discharges water back to the CCS. As described earlier in this chapter, the CCS is a large body of water comprised of a network of canals spread over about 5,900 ac (24 km^2). As with the rest of the Turkey Point site, FPL does not allow the public to access the CCS. The CCS does not directly connect to any other surface water bodies. It is an industrial wastewater (IWW) facility under the Clean Water Act and is not considered "waters of the United States" or "waters of the State" (Figure 3-3).

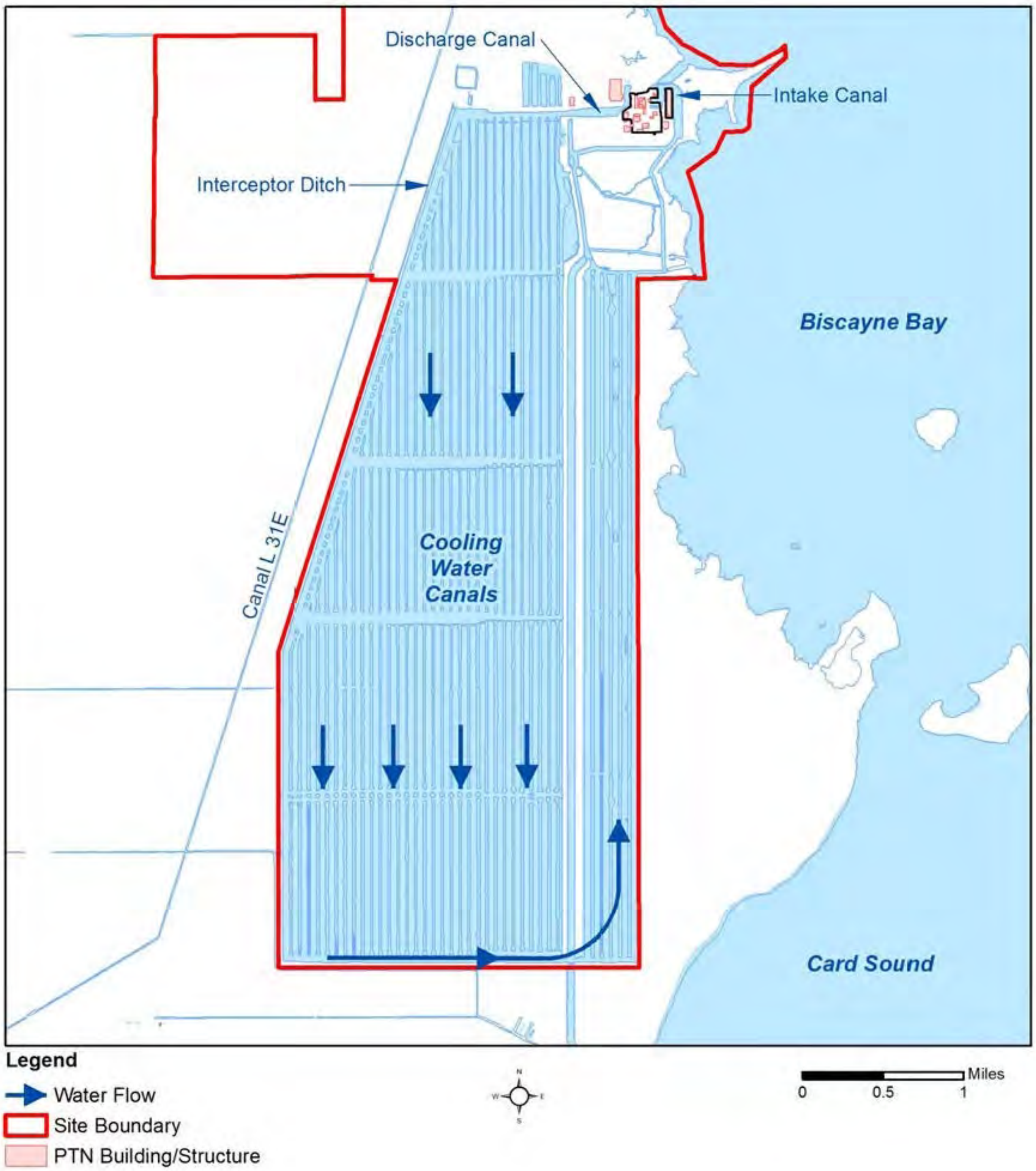
The reactors discharge heated water from the cooling water loop into the discharge canal of the CCS. From the discharge canal, the heated water travels through the length of the canal and loses heat through evaporation. By the time the water returns to the Units 3 and 4 cooling water intake canal, it is lower in temperature than when it was discharged. From the cooling water intake canal, some water is pumped back into the cooling water loop where it is used to dissipate heat from the secondary loop so that the steam water in the secondary loop condenses back into liquid water.

Figure 3-3 illustrates the location where the Units 3 and 4 discharge structure releases heated water into the CCS, the direction of water flow through the CCS, and the location where the

Units 3 and 4 intake structure draws cooling water from the CCS. Section 3.1.3.2, "Cooling Canal System (CCS)," discusses the CCS and its operation in greater detail.

At the Units 3 and 4 cooling water intake structure, water from the CCS flows through bars that prevent large objects from entering the intake structure. Then, the water flows through steel trash racks and into four separated screen wells. The trash racks protect vertical traveling screens against damage from heavy debris. The traveling screens have a 0.38-in (1-cm) mesh size to remove smaller debris. The water then flows to one of four circulating water pumps. The intake structure also contains three pumps that supply water to the condenser. Under normal plant operating conditions, either one, two, or all three of these pumps may be in operation. Inside the cooling water tubes of the condenser, plastic foam balls minimize biological growth and other fouling.

The combined intake of water at the Turkey Point intake structure is 1,872 million gallons per day (mgd) (7 million m^3/day). This water is discharged back to the CCS where it is recirculated for reuse again as cooling water.



Source: FPL 2018f

Figure 3-3 Flow of Water Through the Cooling Canal System

FPL originally built the CCS to service its fossil-fueled units and nuclear generating units. The CCS currently services two nuclear generating units (Units 3 and 4), two retired fossil-fueled units (Units 1 and 2), and one currently operating fossil-fueled unit (Unit 5) in varying capacities. The NRC does not license the operation of the fossil-fueled units.

Historically, the CCS was also part of the cooling water system for Units 1 and 2. The CCS functioned for them as it does for Units 3 and 4. As mentioned earlier, FPL retired Units 1 and 2, so these units no longer generate electricity. However, these retired units still circulate water from the CCS (i.e., discharge water into and withdraw water from the CCS). FPL has placed both units into synchronous condenser mode, which means they support transmission reliability and help to stabilize and optimize electrical grid performance. FPL plans to continue operating Units 1 and 2 in this mode through the period of subsequent license renewal. While in synchronous condenser mode, Units 1 and 2 circulate 17.3 mgd (65,488 m^3/day) of water from the CCS. As Units 1 and 2 no longer produce steam, unlike Units 3 and 4, they no longer discharge heated water to the CCS.

Unit 5 is a currently operating fossil fuel power plant that produces electricity through natural-gas combined-cycle steam generation. It uses four natural gas turbines and one heat-recovery steam-powered generator. It does not use the CCS as part of its cooling water system. Instead, Unit 5 uses cooling towers and obtains water for cooling from groundwater from the Upper Floridan aquifer (see Section 3.5, “Groundwater Resources”). Heat generated by Unit 5 is lost to the atmosphere by the evaporation of water in the plant’s cooling towers.

While Unit 5 does not use the CCS for cooling, it does discharge blowdown water from its cooling towers into the CCS. Blowdown water is produced as a result of the evaporation of water in the cooling tower. Evaporation causes the mineral content of the remaining water that does not evaporate to increase. Blowdown is produced by draining water with high mineral concentrations from the cooling tower and replacing it with fresh water. Blowdown from Unit 5 cooling towers does not contribute heat to the CCS. At 10,000 gallons per day (gpd) (38 m^3/day), the volume of blowdown water discharged from Unit 5 to the CCS is relatively small.

3.1.3.2 Cooling Canal System (CCS)

This section describes the physical dimensions of the CCS and its operation.

<u>Layout of the Cooling Canal System</u>

The CCS covers an area approximately 2-mi (3.2-km) wide by 5-mi (8-km) long and covers an area of approximately 5,900 ac (24 km^2). It was built to act as a cooling reservoir for Units 1, 2, 3, and 4 and as an industrial wastewater facility for liquid discharges from all operations at the Turkey Point site. As previously described, while water from the CCS is circulated through Units 1 and 2, only Units 3 and 4 now use the CCS for cooling. The CCS receives heated water from Units 3 and 4 and distributes the water into 32 feeder channels (canals). Water in the feeder channels flows south into a single collector channel that distributes water to seven return channels (Figure 3-4). As the water flows through the channels, heat is lost, largely through evaporation. Water in the return channels flows north where it is used to cool Units 3 and 4. Units 3 and 4 return heated water to the CCS to repeat the cycle. Flows through the CCS are approximately 1.3 million gallons per minute (gpm) (4.9 million liters per minute (Lpm)) (FPL 2018f).

Prior to the construction of Units 3 and 4, the cooling system for Units 1 and 2 used a cooling system with a once-through design. It withdrew water from and discharged water to Biscayne Bay. However, a 1971 consent decree by the Federal District Court for the Southern District of Florida (United States v. Florida Power and Light Company) required FPL to discharge all cooling water from Turkey Point facilities into a closed-cycle cooling canal system. To comply with this decree, FPL designed and constructed the CCS and ensured that it had no direct surface water connection to any outside water body (i.e., Biscayne Bay or Card Sound) (NRC 2016a). The CCS then replaced the previous Units 1 and 2 once-through cooling system.

The CCS consists of interconnected channels excavated into the underlying bedrock. The bedrock is limestone and forms the top of the Biscayne aquifer. It is important to note that the CCS is not built up above the land surface; instead, it was excavated into the bedrock. Water levels in the channels are below the level of the land surface and below the top of the bedrock (i.e., below the top of the Biscayne aquifer). Therefore, the limestone rock of the Biscayne aquifer forms the bottom and sides of the CCS.

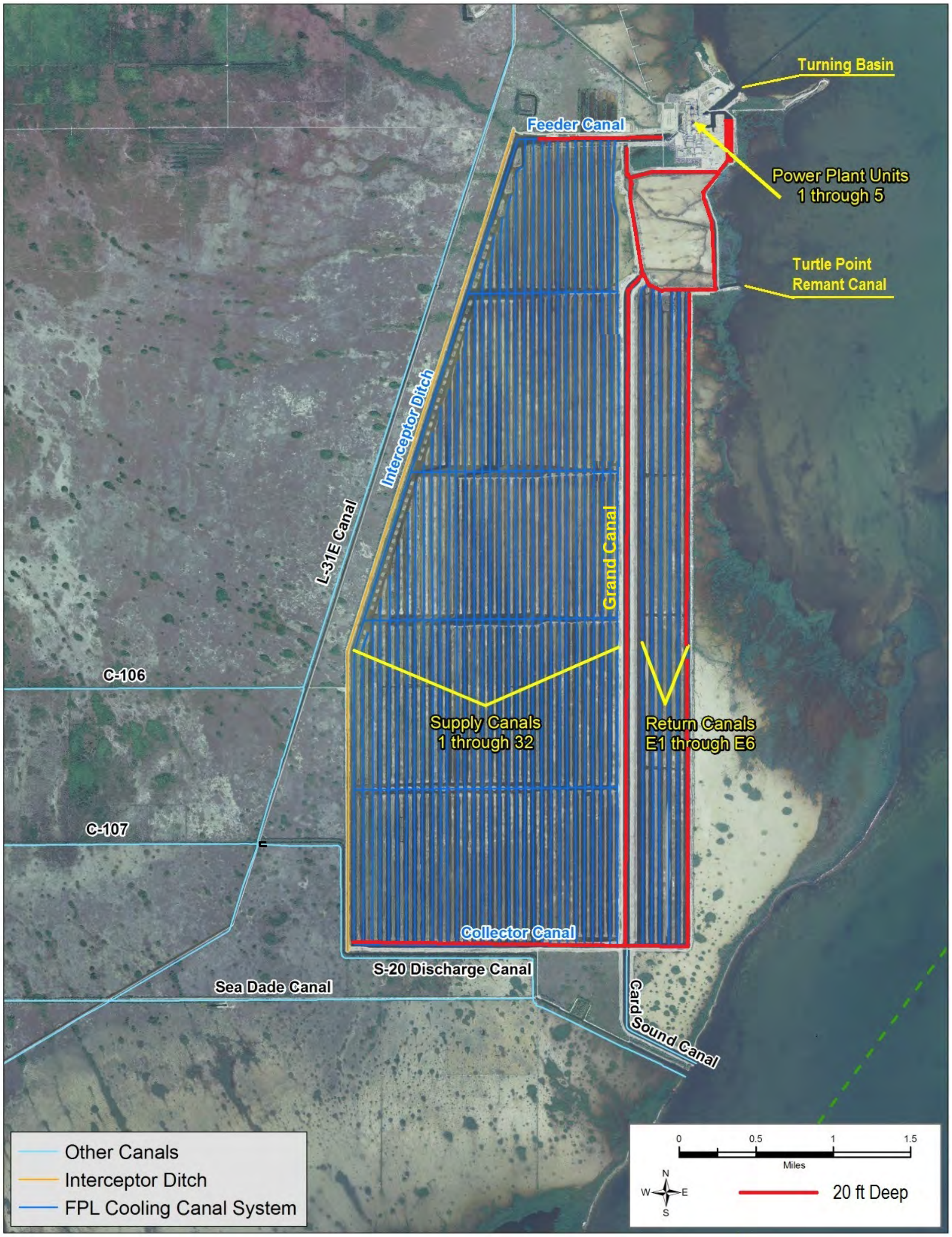
Perimeter berms surround the CCS. These berms are constructed on top of the bedrock and do not contact the water in the CCS. They vary in height from 4 to 10 ft (1.2 to 3 m) above the surface of the bedrock. The widths of the perimeter berms vary from 25 feet to well over 100 feet (7.6 m to 30.5 m) with an average width of more than 50 ft (15.2 m). The perimeter berms are not in contact with water within the CCS. As mentioned previously, the water in the CCS is below the top of the bedrock, while the perimeter berms are built on top of the bedrock. The berms are not designed and built to contain CCS water; rather, these berms are designed and built to prevent surface water from entering the CCS.

Most of the channels within the CCS are about 200 feet (60 m) wide and have a water depth of 1 to 3 feet (0.3 to 1 m). The average canal depth is 2.8 ft (0.85 m) (FPL 2018f). They are separated by 90 foot (27 m) wide berms (NRC 2002c). A few of the channels within the CCS have been excavated to a depth of approximately 20 ft (6.1 m). These deep channels are:

- The east-west distribution channel along the north side of the CCS
- The east-west collection channel along the south side of the CCS
- The north-south channel within the CCS, originally built to discharge water to Card Sound
- The north-south channel along the east side of the CCS
- A few channels in the northeast corner of the CCS that connect to the intake basin (Golder 2008, Morgan & Eklund 2010)

When the CCS was constructed, the previous canals that functioned as intake and discharge canals into Biscayne Bay or Card Sound were either incorporated into the CCS or excluded from it. Those previous canals that were excluded from the CCS have now become remnant dead-end canals. The Barge Turning Basin in Biscayne Bay was walled off from the CCS. Earthen plugs were installed between the CCS and the remnant dead end canals. Within the plugs in the Turtle Point remnant canal that connects to Biscayne Bay and in the Card Sound remnant canal that connects to Card Sound (see Figure 3-4), cement and bentonite slurry walls have been constructed to prevent water seepage through them. In addition, both sides of these plugs are protected with a layer of limestone rock to prevent surface erosion of the plug. The Turtle Point remnant canal plug varies in width from 25 to 40 ft (7.6 to 12 m) and the Card Sound remnant canal plug varies in width from 25 to 50 ft (7.6 to 15 m) (FPL 2016f).

In addition to the channels (canals) within the CCS, an interceptor ditch is located outside and against the west side of the CCS. The ditch is not connected to the CCS or other surface waters. However, it is a part of CCS operations. It parallels the entire length of the west side of the CCS. It is constructed to a depth of approximately 18 ft (5.5 m) (Golder 2008). The purpose of the interceptor ditch is to limit the amounts of saline groundwater that move from beneath the CCS to areas west of the Canal L-31E Levee, to those amounts which would have moved to those areas if the CCS did not exist (Figure 3-4) (FPL 2018f).



Source: Modified from SFWMD 2011a

Figure 3-4 Cooling Canal System and Adjacent Canals

Depending on the head levels (water levels) in the Biscayne aquifer relative to the head levels in Biscayne Bay, groundwater beneath and around the Turkey Point site can either flow towards the bay (east) or inland away from the bay (west). During wet times of the year, when groundwater levels are high, groundwater flow is usually towards the bay. During dry times of the year, when groundwater levels are low, groundwater flow is usually inland away from the bay.

When surface water and groundwater monitoring data around the Turkey Point site indicate that there is a potential for groundwater to flow inland (west), water is pumped from the interceptor ditch and discharged into the CCS. This causes near-surface groundwater to flow towards the interceptor ditch and captures near-surface groundwater below the CCS that is moving west (FPL 2018f). The capture effect is likely limited to the depth of the interceptor ditch, which, at a depth of about 18 ft (5.5 m), is a little deeper than the bottom of the L-31E Canal (Golder 2008).

Cooling Canal System Operation

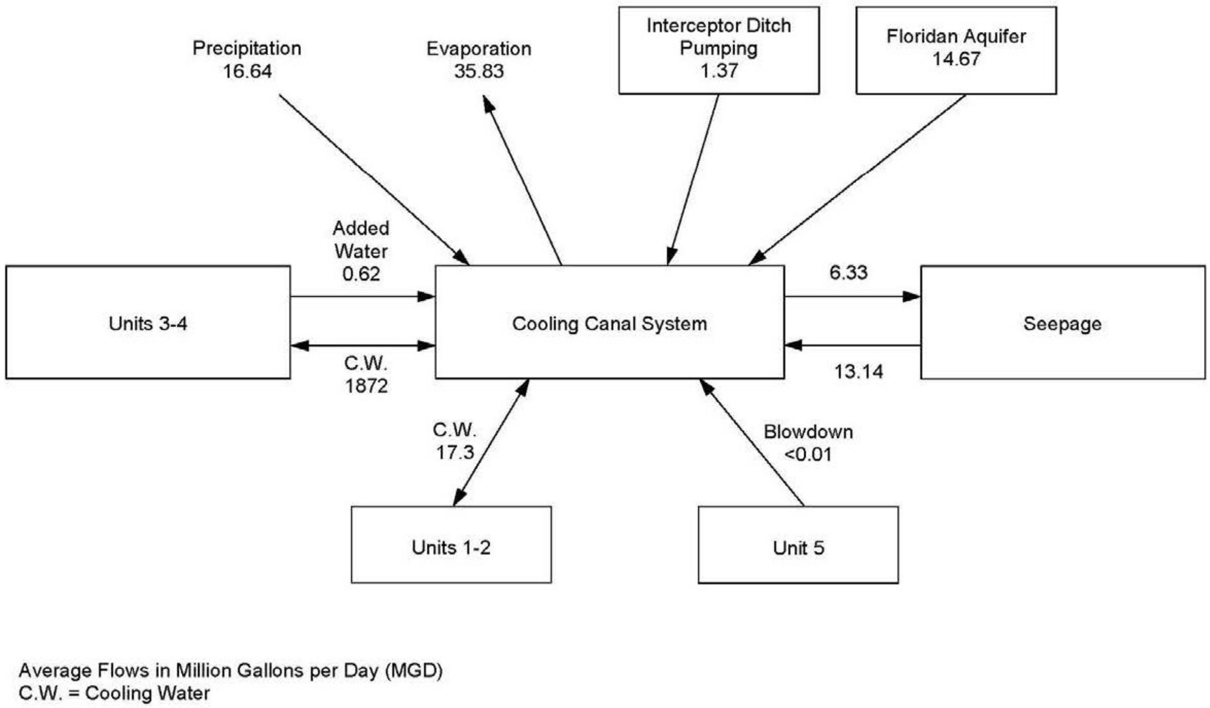
Units 3 and 4 discharge heated water into the CCS. As this water travels through the length of the CCS, it loses heat through evaporation. Evaporation not only removes heat from the water in the CCS, but it also removes some of the water. Water lost through evaporation is replaced by three main sources. The single largest contributor of new water to the CCS is water from precipitation (e.g., rain). Historically, the second largest contributor has been saltwater from the Biscayne aquifer that seeps into the CCS through the limestone bedrock. However, more recently, a different water source has likely overtaken Biscayne aquifer seepage as the second largest contributor of new water to the CCS. Specifically, as further discussed in Section 3.5.2.3, “Groundwater Use,” brackish water supplied by FPL’s wells that withdraw water from the Floridan aquifer is likely a larger contributor of new water to the CCS than is provided by the seepage of water from the Biscayne aquifer.

The CCS receives relatively minor additions of water from discharges from the interceptor ditch and Unit 5 cooling tower blowdown. In extraordinary circumstances, FPL may add water to the CCS from wells (marine wells near Biscayne Bay) that withdraw saltwater from the Biscayne aquifer (see Section 3.5.2.3 for more detail). However, FPL seldom uses these marine wells (FPL 2018f).

As mentioned earlier in this chapter, water in the CCS is not in contact with other surface water bodies. However, the water in the CCS is in direct contact with the Biscayne aquifer and with earthen plugs located in the perimeter of the CCS. These plugs seal off remnant canals from the water in the CCS (FPL 2018f). As the Biscayne aquifer is highly permeable, water would be more readily transmitted through it than through the relatively small areas occupied by the low permeability earthen plugs on the perimeter of the CCS. The perimeter berms are not a likely pathway for water to seep from the CCS as they are not in contact with the CCS water.

Not only does water leave the CCS by evaporation, some of the water also leaves the CCS through the Biscayne aquifer. However, more water moves into the CCS from the Biscayne aquifer than leaves the CCS to the Biscayne aquifer. FPL estimates that the inflow of groundwater from the Biscayne aquifer into the CCS is about twice the volume of outflow of water from the CCS into the Biscayne aquifer (FPL 2018f).

Figure 3-5 shows a typical Turkey Point CCS water budget. The flow quantities shown are based on modeling predictions for the June 2015 through May 2017 period (FPL 2018f). The water balance in the CCS varies in response to hydroclimatic variability and variability in operations of the Turkey Point generating units. Therefore, it is expected that the water balance may not completely close (i.e., inflows balance outflows) over any given time period. Nonetheless, Figure 3-5 provides relative quantities of major inflows to and outflows from the CCS.



Source: Modified from FPL 2018f

Figure 3-5 Illustrated CCS Water Budget for Turkey Point Site Based on Modeling Predictions From June 2015 Through May 2017

Sediments can build up in the channels of the CCS. These sediments can obstruct the lateral flow of water through the CCS and can also lower the rate of water movement into the CCS from the Biscayne aquifer. Therefore, CCS maintenance activities include the removal of accumulated sediments as required to maintain adequate water flow in the CCS (FPL 2018f).

3.1.3.3 Auxiliary Cooling Water System

In addition to the cooling water loop, heat is also removed from Turkey Point operations by the auxiliary cooling water system. This system is much smaller in its water requirements than the cooling water loop. Auxiliary cooling water systems can include emergency core cooling systems, containment spray and cooling systems, emergency feedwater systems, component cooling water systems, and spent fuel pool water systems. At Turkey Point, the auxiliary cooling water system consists of three loops: (1) the component cooling loop, (2) the residual heat removal loop, and (3) the spent fuel pit cooling loop. These loops obtain water from the Miami-Dade County public water supply system and discharge water to the CCS.

3.1.3.4 Fire Protection Water System

Fire protection water protects the plant in the event of a fire. At Turkey Point, the Miami-Dade County public water supply system supplies the fire protection water as described below.

3.1.3.5 Potable Water System

Turkey Point uses approximately 1 mgd (3,800 m^3/day of water from the Miami-Dade County public water supply system. However, a water treatment plant, which supplies pure water for steam-related use, was completed in 2017. This new plant has the ability to treat brackish water at a rate of more than 1 mgd (3,800 m^3/day from onsite wells that withdraw water from the Upper Floridan aquifer (see Section 3.5.2.3, "Groundwater Use"). This will significantly reduce the volume of potable water that FPL needs to obtain from the Miami-Dade County public water supply system.

Potable water is used by the auxiliary cooling water system, fire protection system, and drinking water system. Turkey Point discharges treated waste-process waters into the CCS, and domestic wastewater is sent to an onsite sewage treatment plant. After treatment, FPL disposes of water from the sewage treatment plant into the Biscayne aquifer through an injection well. Beneath the Turkey Point site, the Biscayne aquifer contains saltwater (see Section 3.5.1.4, "Adjacent Surface Water Quality and Cooling Canal System Operation").

3.1.4 Radioactive Waste Management Systems

As a result of normal operations, equipment repairs and replacements, and normal maintenance activities, nuclear power plants routinely generate both radioactive and nonradioactive waste. Nonradioactive waste includes hazardous and nonhazardous waste. There is also a class of waste—called mixed waste—which is both radioactive and hazardous. This section describes the systems that FPL uses to manage (i.e., treat, store, and dispose of) these wastes. This section also discusses other waste minimization and pollution prevention measures commonly employed at nuclear power plants.

The NRC licenses all nuclear plants with the expectation that they will release some radioactive material to both the air and water during normal operations. However, NRC regulations require that gaseous and liquid radioactive releases from nuclear power plants must meet radiation dose-based limits specified in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20, "Standards for Protection Against Radiation," and the as-low-as-is-reasonably-achievable (ALARA) criteria in 10 CFR Part 50, Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents." In other words, the NRC places regulatory limits on the radiation dose that members of the public can receive from a nuclear power plant's radioactive effluents. For this reason, all nuclear power plants use radioactive waste management systems to control and monitor radioactive wastes.

Turkey Point uses the waste disposal system, as needed, to collect and process radioactive materials contained in liquid, gaseous, and solid waste produced as a byproduct of plant operations. The waste disposal system ensures that the dose to members of the public from radioactive effluents is reduced to levels that are ALARA in accordance with the NRC's regulations.

Under an agreement between FPL and the Florida Department of Health (DOH), the DOH Bureau of Radiation Control conducts the Turkey Point radiological environmental monitoring program (REMP). Through the REMP, the Bureau of Radiation Control documents the radiological impact, if any, to the public, site employees, and the environment from radioactive effluents released during operations at Turkey Point. Section 3.1.4.5 below discusses the REMP in more detail.

FPL uses its Offsite Dose Calculation Manual (ODCM) that contains the methods and parameters for calculating offsite doses resulting from liquid and gaseous radioactive effluents. These methods ensure that radioactive material discharges from Turkey Point meet NRC and U.S. Environmental Protection Agency (EPA) regulatory dose standards. The ODCM also contains the requirements for the REMP (FPL 2018f).

3.1.4.1 Radioactive Liquid Waste Management

FPL uses waste management systems to collect, analyze, and process radioactive liquids produced at Turkey Point. These systems reduce radioactive liquids before they are released to the environment. The Turkey Point Units 3 and 4 waste disposal system meets the design objectives of 10 CFR Part 50, Appendix I, and controls the processing, disposal, and release of radioactive liquid, gaseous, and solid wastes.

The plant collects liquid radioactive waste in sumps and tanks in the waste disposal system. Plant personnel then sample and analyze these collected liquid wastes to determine the level of radioactivity and to determine if subsequent treatment is necessary. Personnel then process the liquid radioactive wastes as required by 10 CFR Part 20 and release them into the CCS discharge streams. FPL uses radiation monitors and applies safety features for the discharge stream to avoid releases in excess of 10 CFR Part 20 standards (FPL 2016i).

Radioactive liquid waste entering the waste holdup tanks (WHT) via gravity feed include effluents from the chemistry laboratories, containment sumps, floor drains, showers, and other miscellaneous sources which flow to waste and monitoring holdup tanks. The laundry waste is segregated into one of two monitor tanks. In addition, other sources of liquid wastes include Turkey Point steam generator blowdown and storm drains. These liquids are then pumped to the waste monitor tank where the activity level is determined and recorded prior to discharge through the radiation monitor. The chemical and volume control system (CVCS) receives radwaste liquids from the reactor coolant loop drains, accumulators, and excess letdown.

According to FPL's environmental report submitted as part of the subsequent license renewal application, liquid requiring cleanup before being discharged to the environment is processed by the waste disposal demineralizer. Turkey Point routes the liquid from the waste disposal demineralizer directly to one of the three radwaste facility waste monitor tanks or one of two waste disposal system monitor tanks (FPL 2016i, Section 11.1.2). When one of the waste monitor tanks is filled, it is isolated, recirculated, and sampled for analysis while one of the other two tanks is in service. If analysis confirms the activity level is suitable for discharge, the liquid is pumped through a flow meter and a radiation monitor and then released to the cooling canals of the industrial wastewater facility. Otherwise, it can be returned to a waste holdup tank for reprocessing (FPL 2016i, Section 11.1.2). Turkey Point monitors radioactive liquid discharge from its systems to ensure that activity concentrations do not exceed regulatory limits.

FPL's use of these radioactive waste systems and the procedural requirements in the Offsite Dose Calculation Manual ensure that the dose from radioactive liquid effluents at Turkey Point complies with NRC and EPA regulatory dose standards.

FPL calculates dose estimates for members of the public using radioactive liquid and gaseous effluent release data and atmospheric and aquatic transport models. Unit 3 and Unit 4 share the liquid waste treatment system. Generally, FPL allocates all liquid releases on a 50/50 basis to each unit. In addition, both units also share the gaseous releases from the shared gaseous waste treatment system on a 50/50 basis. Turkey Point's annual radioactive effluent release reports contain a detailed presentation of the radioactive liquid and gaseous effluents released from Turkey Point and the resultant calculated doses. The NRC staff reviewed 5 years of radioactive effluent release data from 2013 through 2017 (FPL 2013b, 2014d, 2015a; 2016l, FPL 2017e). A 5-year period provides a dataset that covers a broad range of activities that occur at a nuclear power plant, such as refueling outages, routine operation, and maintenance that can affect the generation of radioactive effluents. The NRC staff compared the data against NRC dose limits and looked for indications of adverse trends (e.g., increasing dose levels) over the period spanning from 2013 through 2017. Since the radioactive liquid effluents are released from common areas shared by both Unit 3 and Unit 4, the resultant calculated doses presented in the effluent release are divided in half to evaluate compliance with the Appendix I to 10 CFR Part 50 dose criteria. The NRC staff's review of Turkey Point's radioactive liquid effluent control program showed that radiation doses to members of the public were controlled within the NRC's and EPA's radiation protection standards contained in Appendix I to 10 CFR Part 50, 10 CFR Part 20, and 40 CFR Part 190. No adverse trends were observed in the dose levels. Routine plant refueling and maintenance activities currently performed will continue during the license renewal term. Based on the past performance of the radioactive waste system to maintain doses from radioactive liquid effluents to be ALARA, similar performance is expected during the license renewal term. The following summarizes the calculated doses from radioactive liquid effluents released from Turkey Point Units 3 and 4 during the most recent available year (2017):

Turkey Point Unit 3 in 2017

- The total-body dose to an offsite member of the public from Turkey Point Unit 3 radioactive effluents was 2.38×10^{-4} millirem (mrem) (2.38×10^{-6} millisievert (mSv)), which is well below the 3 mrem (0.03 mSv) dose criterion in Appendix I to 10 CFR Part 50.
- The maximum organ dose (gastrointestinal tract) to an offsite member of the public from Turkey Point Unit 3 radioactive effluents was 2.76×10^{-4} mrem (2.76×10^{-6} mSv), which is well below the 10 mrem (0.1 mSv) dose criterion in Appendix I to 10 CFR Part 50.

Turkey Point Unit 4 in 2017

- The total-body dose to an offsite member of the public from Turkey Point Unit 4 radioactive effluents was 2.38×10^{-4} millirem (mrem) (2.38×10^{-6} millisievert (mSv)), which is well below the 3 mrem (0.03 mSv) dose criterion in Appendix I to 10 CFR Part 50.
- The maximum organ dose (gastrointestinal tract) to an offsite member of the public from Turkey Point Unit 4 radioactive effluents was 2.76×10^{-4} mrem (2.76×10^{-6} mSv), which is well below the 10 mrem (0.1 mSv) dose criterion in Appendix I to 10 CFR Part 50.

The NRC staff's review of FPL's radioactive liquid effluent control program shows that the applicant maintained radiation doses to members of the public that were within NRC's and

EPA's radiation protection standards in Appendix I to 10 CFR Part 50, 10 CFR Part 20, and Title 40, "Protection of Environment," of the *Code of Federal Regulations* (40 CFR) Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations." The NRC staff observed no adverse trends in the dose levels.

Routine plant refueling and maintenance activities at Turkey Point will continue during the subsequent license renewal term. Based on FPL's past performance in operating a radioactive waste system at Turkey Point that maintains ALARA doses from radioactive liquid effluents, the NRC staff expects that FPL will maintain similar performance during the subsequent license renewal term.

3.1.4.2 Radioactive Gaseous Waste Management

Radioactive gaseous waste generated at Turkey Point is collected, processed, and stored until its radioactivity level is low enough to permit discharge to the environment at concentrations below 10 CFR Part 20 standards (FPL 2016i, Section 1.2.4) through the waste disposal system. Sources of the radioactive gaseous waste at Turkey point include gas decay tanks, containment purges, the refueling water storage tank via the vent line, the Turkey Point equipment hatch during outages, and releases incidental to plant operations. This radioactive gaseous waste is created during plant operation from degassing reactor coolant discharge to the chemical and volume control system, displacement of cover gases, miscellaneous equipment vents, relief valves, and sampling operation and gas analysis for hydrogen and oxygen in cover gases. Most of the gas received by the waste disposal system is cover gas displaced from the chemical and volume control system holdup tanks as they fill with liquid. Gaseous waste is stored in decay tanks for natural decay and is then released through the monitored plant vent. The cover gas is reused to minimize the number of tank releases. The gaseous waste is monitored and released at a permissible rate and activity as prescribed by the ODCM. Radioactive gaseous effluents from Turkey Point Units 3 and 4 are released through four monitored release points: a common plant vent via a stack above the containment building (~200 feet), the Unit 3 spent fuel pit vent (~110 feet), and the condenser air ejector vents (~51 feet) from each unit.

Gases that are vented to the vent header flow to the waste gas compressor suction header. One of two compressors is in continuous operation with the second unit instrumented to act as backup for peak load conditions or failure of the first compressor. From the compressors, gas flows to one of the gas decay tanks. Gas held in the decay tanks can either be returned to the chemical and volume control system holdup tanks or discharged to the atmosphere via the plant vent at a controlled rate through a radiation monitor if it has decayed sufficiently for release (FPL 2016i, Section 11.1.2). The gases in the tanks are sampled and analyzed to determine the radioactivity level. The radioactivity level contained in each gas decay tank is restricted (1) to ensure that if an uncontrolled release of the tank's contents were to occur, the resulting total body exposure to an individual at the exclusion area boundary would not exceed 500 millirems per year (mrem/yr) (5 millisieverts per year (mSv/yr)) and (2) to control the concentration of potentially explosive gases to below flammability limits. The decay tanks are used to contain the compressed waste gases (hydrogen, nitrogen, and fission gases) until they decay and are ready to be vented to the atmosphere.

FPL's use of this gaseous radioactive waste system and adherence to the procedural requirements in the ODCM ensure that the dose from radioactive gaseous effluents complies with NRC and EPA regulatory dose standards.

As discussed above, FPL calculates dose estimates for members of the public using radioactive liquid and gaseous effluent release data and atmospheric and aquatic transport models. Unit 3 and Unit 4 share the gaseous waste treatment system. The following summarizes the calculated doses from radioactive gaseous effluents released from Turkey Point during 2017:

Turkey Point Unit 3 in 2017

- The air dose at the site boundary from gamma radiation in gaseous effluents from Turkey Point Unit 3 was 1.30×10^{-5} millirad (mrad) (1.3×10^{-7} milligray), which is well below the 10 mrad (0.1 milligray) dose criterion in Appendix I to 10 CFR Part 50.
- The air dose at the site boundary from beta radiation in gaseous effluents from Turkey Point Unit 3 was 2.96×10^{-5} mrad (2.96×10^{-7} milligray) dose which is well below the 20 mrad (0.2 milligray) dose criterion in Appendix I to 10 CFR Part 50.
- The dose to an organ (thyroid) from radioactive iodine, radioactive particulates, and carbon from Turkey Point Unit 3 was 1.01×10^{-1} mrem (1.01×10^{-3} mSv), which is below the 15 mrem (0.15 mSv) dose criterion in Appendix I to 10 CFR Part 50.

Turkey Point Unit 4 in 2017

- The air dose at the site boundary from gamma radiation in gaseous effluents from Turkey Point Unit 4 was 9.02×10^{-6} mrad (9.02×10^{-8} milligray), which is well below the 10 mrad (0.1 milligray) dose criterion in Appendix I to 10 CFR Part 50.
- The air dose at the site boundary from beta radiation in gaseous effluents from Turkey Point Unit 4 was 2.07×10^{-5} mrad (2.07×10^{-7} milligray) dose which is well below the 20 mrad (0.2 milligray) dose criterion in Appendix I to 10 CFR Part 50.
- The dose to an organ (thyroid) from radioactive iodine, radioactive particulates, and carbon from Turkey Point Unit 4 was 1.19×10^{-1} mrem (1.19×10^{-3} mSv), which is below the 15 mrem (0.15 mSv) dose criterion in Appendix I to 10 CFR Part 50.

The NRC staff's review of Turkey Point's radioactive gaseous effluent control program showed radiation doses to members of the public that were well below NRC and EPA radiation protection standards contained in Appendix I to 10 CFR Part 50, 10 CFR Part 20, and 40 CFR Part 190. The NRC staff observed no adverse trends in the dose levels.

Routine plant refueling and maintenance activities at Turkey Point will continue during the subsequent license renewal term. FPL's past performance operating the radioactive waste system demonstrates that it is able to maintain ALARA doses from radioactive gaseous effluents. Based on this record of past performance, the NRC staff expects that FPL will maintain similar performance during the subsequent license renewal term.

3.1.4.3 Radioactive Solid Waste Management

At Turkey Point, low-level radioactive wastes (LLRW) are packaged and stored for subsequent shipment and offsite burial under the plant's waste disposal system. FPL packages Turkey Point radioactive waste shipments in accordance with NRC requirements (10 CFR Part 71, "Packaging and Transportation of Radioactive Material"), and U.S. Department of Transportation (USDOT) requirements (Title 49, "Transportation," of the *Code of Federal Regulations* Part 173, "Shippers—General Requirements for Shipments and Packagings," and Part 178, "Specifications for Packagings").

Under the waste disposal system, FPL packages all solid wastes in high-integrity containers (HICs) for removal to disposal facilities. The HICs are designed to be placed into transfer casks for shipment offsite for disposal. The HICs are also designed to be stored in the LLRW storage facility while awaiting shipment offsite for disposal. The waste disposal system has been designed as a waste process system, which includes demineralizers, monitor tanks, a condensate tank, and associated pumps. Solid radioactive waste and potentially radioactive wastes include spent resins, spent filters, and miscellaneous materials. Solid radioactive wastes also include solids recovered from the reactor coolant system (RCS), solids in contact with the liquids or gases associated with the reactor coolant process systems, and solids used in support of the reactor coolant system operation. The largest volume of solid radioactive waste is LLRW, which includes bead resin, spent filters, and dry active waste from outages and routine maintenance. Turkey Point has developed long-term plans which ensure that radioactive waste generated during the subsequent license renewal term will be sent directly for disposal, stored onsite in existing structures, or shipped to an offsite licensed facility for processing and disposal (FPL 2018f).

LLRW is classified as Class A, Class B, or Class C (minor volumes are classified as greater than Class C). Class A includes both dry active waste and processed waste (e.g., dewatered resins). Classes B and C normally include processed waste and irradiated hardware. The majority of LLRW generated at Turkey Point during the subsequent license renewal period is expected to be Class A waste and could be shipped to licensed processors, such as the Energy Solutions facility in Oak Ridge, TN, for reduction and repackaging, and then shipped to a Class A disposal facility such as the Energy Solutions facility in Clive, UT. Class B and C wastes would constitute a low percentage by volume of the total LLRW generated. The LLRW storage facility at Turkey Point can currently store approximately 5 years of Class B and Class C wastes.

Class B and C wastes can be shipped to the Energy Solutions facility in Oak Ridge, TN, where they can then be shipped to the Waste Control Specialist facility in Texas, which is licensed for disposal of Classes A, B, and C wastes. Disposal of waste greater than Class C is the responsibility of the Federal Government. The NRC licenses the storage of LLRW waste under the general license provided to power reactor licensees under 10 CFR Part 50 (FPL 2016f).

In 2017, a total of eight LLRW shipments were made from Turkey Point to the Energy Solutions, Bear Creek Road Facility (Oak Ridge, TN) (FPL 2018f) and Energy Solutions, Gallaher Road Facility (Kingston, TN) (FPL 2018f). The total volume and radioactivity of LLRW shipped offsite in 2017 was 6.00×10^{2} cubic meters (m^3) (2.12×10^{4} cubic feet (ft^3)) and 1.11×10^{0} curies (Ci) (4.12×10^{4} megabecquerels (MBq)), respectively (FPL 2018f). During the subsequent license renewal period, Turkey Point would continue with routine plant operation, refueling outages, and maintenance activities that generate radioactive solid waste. The NRC also expects Turkey Point to continue to ship radioactive solid waste offsite for disposal during the subsequent license renewal period.

3.1.4.4 Radioactive Waste Storage

At Turkey Point, LLRW is stored temporarily onsite before being shipped offsite for treatment or disposal at licensed LLRW treatment and disposal facilities. In its environmental report for the Turkey Point subsequent license renewal application, FPL states that Turkey Point has sufficient existing capability to store LLRW onsite. FPL also states in its environmental report that its long-term needs for generated LLRW storage (including during the subsequent license renewal term) do not require constructing additional onsite storage facilities (FPL 2018a).

Turkey Point stores its spent fuel in a spent fuel pool and in an onsite independent spent fuel storage installation (ISFSI). The ISFSI safely stores spent fuel onsite in licensed and approved dry cask storage containers.

If the U.S. Department of Energy does not begin to take possession of the spent nuclear fuel in 2031, FPL may need to expand the existing capacity of the Turkey Point Units 3 and 4 ISFSI. This would require FPL to construct a new ISFSI pad to accommodate additional spent nuclear fuel generated during the subsequent license renewal term (FPL 2018g). Alternatively, FPL may choose to utilize a higher density storage system to create additional storage capacity and, thereby, reduce the need to expand the ISFSI. At this time, FPL has not yet determined whether to expand the ISFSI.

3.1.4.5 Radiological Environmental Monitoring Program

As stated above, the Florida Department of Health (DOH) Bureau of Radiation Control, per an agreement between FPL and the DOH, conducts a radiological environmental monitoring program (REMP) to assess the radiological impact, if any, to the public and the environment from the operations at Turkey Point Units 3 and 4.

The REMP measures the aquatic, terrestrial, and atmospheric environment for ambient radiation and radioactivity. Monitoring is conducted for the following: direct radiation, air, water, groundwater, broad leaf vegetation, fish, shellfish, and sediment. The REMP also measures background radiation (i.e., cosmic sources, global fallout, and naturally occurring radioactive material, including radon).

In addition to the REMP, Turkey Point has an onsite groundwater protection program designed to monitor the onsite plant environment for detection of leaks from plant systems and pipes containing radioactive liquid (FPL 2018f). Information on the groundwater protection program is contained in Section 3.5.2, “Groundwater Resources,” of this SEIS.

FPL states in its environmental report that it has detected tritium in groundwater but has not detected Turkey Point Units 3 and 4-related gamma-emitting isotopes since establishing its NEI 07-07, “Industry Ground Water Protection Initiative,” program (FPL 2018f). Section 3.5.2.2, “Groundwater Quality,” provides a summary of radionuclides detected in groundwater. For 2018, the highest observed level of tritium in Turkey Point groundwater, outside the boundaries of the CCS, was reported as 3,390 picocuries per liter (pCi/L). For comparison, the EPA primary drinking water standard or maximum contaminant level (MCL) for tritium is 20,000 pCi/L (40 CFR 141.66). Tritium is also found in surface water onsite. For 2018, the maximum level measured was 21,851 pCi/L in the CCS. While some tritium levels measured in the CCS were found to be higher than the EPA drinking water standard of 20,000 pCi/L, they were still lower than the limits prescribed by Turkey Point Unit 3 and 4’s Offsite Dose Calculation Manual (FPL 2013a) for the plant, which for tritium is 30,000 pCi/L. Further, no surface water or groundwater at the site is used for potable purposes.

The NRC staff reviewed 5 years of annual radiological environmental monitoring data from 2014 through 2018 (FPL 2015b, FPL 2016j, FPL 2017d, FPL 2018k, FPL 2019c). A 5-year period provides a dataset that covers a broad range of activities that occur at a nuclear power plant, such as refueling outages, routine operation, and maintenance that can affect the generation and release of radioactive effluents into the environment. The NRC staff looked for indications of adverse trends (e.g., increasing radioactivity levels) over the period of 2014 through 2018.

Based on its review of this information, the NRC staff found no apparent increasing trend in concentration or pattern indicating either a new inadvertent release or persistently high tritium concentrations that might indicate an ongoing inadvertent release from Turkey Point Units 3 and 4. The groundwater monitoring program at Turkey Point Units 3 and 4 is robust, and any future leaks that might occur during the subsequent license renewal period should be readily detected. All spills are well monitored, characterized, and actively remediated. The data show that there were no significant radiological impacts to the environment from operations at Turkey Point Units 3 and 4.

3.1.5 Nonradioactive Waste Management Systems

Like any other industrial facility, nuclear power plants generate wastes that are not contaminated with either radionuclides or hazardous chemicals.

Turkey Point has a nonradioactive waste management system to handle its nonradioactive hazardous and nonhazardous wastes. The waste is managed in accordance with FPL's procedures. Turkey Point has a contact stabilization treatment plant for sanitary waste (FPL 2018f) which is located west of the power block area. The treated wastewater is disposed of through an approximately 25-cm (10-in.) diameter, 15-m (50-ft) deep underground injection well located adjacent to the treatment facility. FPL disposes of residuals (wet sludge) at the Miami-Dade Water and Sewer Department's (MDWSD) South District Wastewater Treatment Facility (FPL 2018f).

The Miami-Dade County Department of Solid Waste Management is responsible for solid waste collection, transport, and disposal in unincorporated portions of the county and in eight municipalities. The Department of Solid Waste Management solid waste disposal system consists of a resource recovery waste-to-energy facility and two landfills: (1) the North Dade Landfill (a trash-only facility) and (2) the South Dade Landfill (a garbage and trash facility), which are supported by three regional waste transfer stations. An approved solid waste contractor collects and transports the solid waste generated at Turkey Point for disposal at county facilities (FPL 2018f). Listed below is a summary of the types of waste materials generated and managed at Turkey Point.

- Turkey Point is classified as a small quantity, hazardous waste generator. The amounts of hazardous wastes generated are only a small percentage of the total wastes generated. These wastes consist of paint wastes; spent, off-specification, and shelf-life expired chemicals; and occasional project-specific wastes (FPL 2018f).
- Turkey Point's nonhazardous wastes include plant trash and nonradioactive waste (FPL 2018f).
- Other wastes include fluorescent lamps, batteries, and devices containing mercury; electronics; and antifreeze (FPL 2018f).

For the fossil fuel facilities (Units 1 and 2, and Unit 5) and the Turkey Point site land management facilities, FPL routes sanitary waste from showers, water closets, toilets, etc. to Miami-Dade County-approved onsite septic systems. For the nuclear generating Units 3 and 4, FPL routes domestic wastewater to an onsite, county- and State-permitted, contact stabilization sewage treatment plant. This wastewater treatment plant (WWTP) discharges effluents to an onsite, permitted, single Class V, Group 3 gravity underground injection well used to dispose of domestic wastewater effluent (FPL 2018f). Wastewater residuals generated by this plant are transported to an approved offsite facility (FPL 2018f). The clarified wastewater sludge is monitored according to operational protocol 0-NCAP-103 to ensure that the disposed material does not present an environmental or public health risk.

3.1.6 Utility and Transportation Infrastructure

The utility and transportation infrastructure at a nuclear power plant typically interfaces with the public infrastructure systems available in the region. Such public infrastructure includes utilities, such as suppliers of electricity, fuel, and water, as well as roads and railroads that provide access to the site. The following sections briefly describe the existing utility and transportation infrastructure at Turkey Point. Unless otherwise cited, the source of the Turkey Point site-specific information in this section is FPL's environmental report submitted as part of the subsequent license renewal application (FPL 2018f).

3.1.6.1 Electricity

Nuclear power plants generate electricity for other users; however, they also use their own generated electricity to operate. In the event of a malfunction or interruption of onsite nuclear power generation at Turkey Point, the facility would depend on offsite power sources to provide power to engineered safety features and emergency equipment. If both Turkey Point nuclear power generation and offsite power sources fail, the facility will use planned independent backup power sources.

3.1.6.2 Fuel

Under its current renewed facility operating licenses, Turkey Point Units 3 and 4 are licensed for fuel that is slightly enriched uranium dioxide (up to 5.0 percent by weight uranium-235). FPL operates the reactors at an equilibrium core maximum fuel discharge burnup rate of 62,000 megawatt-days per metric ton uranium (MWd/MTU). FPL refuels each nuclear unit on an 18-month schedule, which means at least one refueling every year and two refuelings every third year. FPL loads the core fuel in three regions. New fuel is introduced into the outer region, and partially spent fuel is moved inward into a checkerboard pattern at successive refuelings when the inner region fuel is discharged to spent fuel storage (FPL 2018f).

The Turkey Point spent fuel storage pit provides underwater storage of spent fuel assemblies and control rods after their removal from the reactor. The spent fuel pit is located in the auxiliary building and can store up to 1,535 fuel assemblies, including 131 spent or fresh fuel assemblies in the cask area rack, as well as miscellaneous fuel handling tools. FPL designed the cask area of the spent fuel pit for the installation of a fuel transfer cask to allow fuel transfer operations. The Turkey Point site has an ISFSI to provide Unit 3 and Unit 4 spent fuel capacity (FPL 2018f).

3.1.6.3 Potable Water

In addition to cooling and auxiliary water (previously described in detail in Section 3.1.3), nuclear power plants require potable water for sanitary and everyday uses by personnel (e.g., drinking, showering, cleaning, laundry, toilets, and eye washes). At Turkey Point, the Miami-Dade County public water supply system supplies potable water to the site.

3.1.6.4 Transportation Systems

All nuclear power plants are served by controlled access roads. In addition to roads, many plants also have railroad connections for moving heavy equipment and other materials. Plants located on navigable waters may have facilities to receive and ship loads on barges.

The Turkey Point site transportation network includes U.S. highways, interstate highways, multilane divided State highways, and local streets. Miami-Dade County operates public transportation services including rail and bus service. Miami-Dade County also offers air transportation infrastructure including airports, heliports, and a seaplane base; a seaport for commercial freight and passenger service; and an intermodal transportation hub for air, rail, and ship (FPL 2018f). Section 3.10.6, "Local Transportation," describes these systems in more detail.

3.1.6.5 Power Transmission Systems

For license renewal, including subsequent license renewal, the NRC (2013b) evaluates as part of the proposed action the continued operation of those power transmission lines that connect the nuclear power plant to the substation where it feeds electricity into the regional power distribution system. The NRC also evaluates the continued operation of the transmission lines that supply outside power to the nuclear plant from the grid. In its environmental report, FPL stated the locations of in-scope transmission lines, which are shown in Figure 3-6 (FPL 2018f). Turkey Point is connected to the 230-kV switchyard through an approximately 590-foot (180-m) transmission line (FPL 2018f).

Figure 3-6 Turkey Point In-Scope Transmission Lines (FPL 2018f)

3.1.7 Nuclear Power Plant Operations and Maintenance

FPL's Turkey Point maintenance activities include inspection, testing, and surveillance to maintain the current licensing basis of the facility and to ensure compliance with environmental and safety requirements. Various programs and activities are currently in place at Turkey Point to maintain, inspect, and monitor the performance of facility structures, systems, and components. These activities include, but are not limited to, (1) in-service inspections of safety-related structures, systems, and components, (2) quality assurance program, (3) fire protection program, and (4) monitoring of radioactive and nonradioactive water chemistry.

Additional Turkey Point maintenance programs include those implemented to meet technical specification surveillance requirements and those implemented in response to NRC generic communications. Such additional programs include various periodic maintenance, testing, and inspection procedures necessary to manage the effects of aging on structures and components. FPL performs certain program activities during the operation of the units and performs others during scheduled refueling outages. As stated above, reactor refueling at Turkey Point occurs on an 18-month cycle (FPL 2018f).

3.2 Land Use and Visual Resources

Sections 2.2.1, 2.2.8.3, and 2.2.8.4 of NUREG–1437, Supplement 5 (the SEIS for the Turkey Point's initial license renewal) describe land use and visual resources at Turkey Point Units 3 and 4 (NRC 2002c). This information is incorporated here by reference. Section 2.2 of NUREG-2176, "Environmental Impact Statement for Combined Licenses (COLs) for Turkey Point Nuclear Plant Units 6 and 7" (NRC 2016a), also describes the land use at the Turkey Point site. This information is also incorporated here by reference (NRC 2016a). No new and significant information was identified during the review of FPL's environmental report for the Turkey Point Units 3 and 4 subsequent license renewal (FPL 2018f), during the site audit at Turkey Point, the scoping process, or the evaluation of other available information that would alter the discussion contained in the SEIS for Turkey Point's initial license renewal.

3.2.1 Land Use

Turkey Point Units 3 and 4 are located on the shore of Biscayne Bay in south Florida's Miami-Dade County. The plant site is approximately 25 mi (40 km) south-southwest of Miami. The nearest incorporated city limits are Homestead, which is approximately 9 mi (14.5 km) west-northwest of the plant site, and Florida City, which is approximately 9 mi (14.5 km) west of the plant site. The nearest community to the south is Key Largo, which is in Monroe County, FL and is approximately 30 mi (48 km) by road from the plant site.

3.2.1.1 Onsite Land Use

Turkey Point Units 3 and 4 and associated structures and features, including the cooling canal system, occupy approximately 8,000 ac (3,200 ha). The largest land use and land cover categories within the Turkey Point property boundary are wetlands and open water, which together compose approximately 93 percent of the site. The next largest land use category is developed land (to support Turkey Point plant operations), which is approximately 6 percent of the site (FPL 2018f).

Miami-Dade County has designated the land use zoning at the Turkey Point site, including all units, undeveloped lands, and the cooling canal system, as either IU-3 (industrial districts, unlimited manufacturing) or GU (interim district, uses depend on the character of the neighborhood). Specifically, Turkey Point Units 3 and 4 are located on land zoned IU-3. The remainder of the Turkey Point site is zoned GU, an interim district. In an interim district, zoning-assigned land uses depend on the character of the neighborhood; otherwise, EU-2 standards apply (single-family 5-ac estate district) (FPL 2018f).

3.2.1.2 Coastal Zone

Section 307(c)(3)(A) of the Coastal Zone Management Act (CZMA) (16 U.S.C. 1456(c)(3)(A)) requires that applicants for Federal licenses who conduct activities in a coastal zone provide a certification that the proposed activity complies with the enforceable policies of the State's coastal zone program. Turkey Point Units 3 and 4 are within the Florida coastal zone. The Florida Department of Environmental Protection (FDEP) issued a license that constitutes concurrence that FPL's activities at Turkey Point are consistent with the State of Florida's approved coastal management program. The most recent conditions of certification for Turkey Point Units 3 through 5 (PA 03-45) show Turkey Point Units 3 and 4 as being certified to be consistent in 2008, with several modifications since then, the most recent having been issued on March 29, 2016 (FDEP 2016b).

Land to the south and west of the Turkey Point site is in the Everglades Mitigation Bank where wetlands are created, restored, or enhanced to provide compensatory mitigation of wetland losses elsewhere. Under the joint federally and State-operated mitigation bank program, both public and private entities can own lands in the program. FPL owns the Everglades Mitigation Bank land, which comprises approximately 13,000 ac (5,300 ha) of relatively undisturbed freshwater and estuarine wetlands. The U.S. Army Corps of Engineers, the EPA, the Natural Resources Conservation Service, the U.S. Fish and Wildlife Service (FWS), and the National Marine Fisheries Service (NMFS) review and comment on mitigation bank permit applications and subsequent Mitigation Banking Instruments issued by the U.S. Army Corps of Engineers to ensure consistency with specific laws and provisions, including Section 404 of the Federal Water Pollution Control Act (also known as the Clean Water Act [CWA]) permit program, the wetland conservation provisions of the Food Security Act, the National Environmental Policy Act (NEPA), and several other statutory provisions. The FDEP permits mitigation banks for utility companies within Florida pursuant to the Florida Mitigation Banking Rule and other State authorities.

3.2.1.3 Offsite Land Use

Biscayne Bay, located immediately adjacent to Turkey Point, is the predominant natural feature in the vicinity of the Turkey Point site. As described earlier, the largest land use and land cover category at Turkey Point is wetlands and open water, of which open water is the largest component. The next largest land use and land cover category is wetland areas, comprised of woody and emergent herbaceous wetlands. And finally, the third largest land use and land cover category is developed land.

The pattern of land use and urban growth has remained essentially unchanged in Miami-Dade County since 1975, which is when the County released the original Comprehensive Master Development Plan (CMDP). The CMDP establishes a growth policy that encourages development (1) at a rate commensurate with projected county population and economic growth, (2) in a contiguous pattern around a network of high-intensity urban centers connected to transportation facilities, and (3) in locations which optimize efficiency in public service delivery and conservation of valuable natural resources (MDC 2017a).

3.2.2 Visual Resources

The Turkey Point site is relatively flat and sparsely populated with trees. The most visible features are the containment structures for Units 3 and 4. They are the tallest structures on the site at approximately 210 feet (64 m) tall (FPL 2018f). However, trees and other vegetation screen most of Turkey Point Units 3 and 4 and supporting structures from roadways and recreational areas west of the plant site. In addition, vegetation blocks the view of Turkey Point Units 3 and 4 from the Biscayne National Park Dante Fascell Visitor Center and Homestead Bayfront Park, although the units can be clearly seen from other areas of Biscayne National Park, including much of Biscayne Bay. At night, light from Turkey Point is visible from several locations outside the site, including from the Homestead-Miami Speedway and Biscayne Bay (NRC 2016a).

3.3 Meteorology, Air Quality, and Noise

This section describes the meteorology, air quality, and noise environment in the vicinity of Turkey Point.

3.3.1 Meteorology and Climatology

The State of Florida is characterized by a humid subtropical climate, with long, hot summers and short, mild winters. The climate of Florida is largely influenced by the warm waters of the Gulf of Mexico and western Atlantic. Air from the Gulf of Mexico moderates summer heat, shortens winter cold spells, and provides moisture and heavy rainfall during all seasons. Florida is subject to frequent thunderstorms during the summer, and historically, the State experiences the highest annual number of thunderstorms in the United States. The State is also vulnerable to tornados and tropical cyclones (tropical storms and hurricanes) that develop in the Gulf of Mexico and western Atlantic. On average, tropical cyclones strike Florida three times every 5 years, and the Florida coast is vulnerable to severe flooding from these storms (NOAA 2013a, Runkle et al. 2017). Turkey Point is located on the lower east coast of Florida. The general climate in this area is subtropical marine, characterized by a long warm summer with abundant rainfall followed by a mild dry winter (NCDC 2017). The Azores-Bermuda high-pressure system dominates the circulation pattern in this region for most of the year, causing a tropical air mass to prevail. Occasional cold continental air masses displace the maritime air during winter (NRC 2016a).

Section 2.9.1 of the EIS for the Turkey Point Units 6 and 7 combined licenses (NRC 2016a) describes in detail the area's specific climatological and meteorological conditions including wind, temperature, precipitation, and severe weather. The NRC staff incorporates into this SEIS the information in Section 2.9.1 of the COL EIS by reference. The NRC staff did not identify any new and significant information relevant to the climatological and meteorological environment beyond the information described in the EIS for the Turkey Point Units 6 and 7 combined licenses that would alter the discussion contained in Section 2.9.1 of the COL EIS.

In the past 67 years (1950–2017), the following numbers of severe weather events have been reported in Miami-Dade County (NCDC 2018):

- Hurricane: 10 events
- Tornado: 137 events
- Thunderstorm: 312 events
- Flood: 13 events

3.3.2 Air Quality

Under the Clean Air Act (CAA), 42 U.S.C. 7401, et seq., the EPA has set primary and secondary National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50, "National Primary and Secondary Ambient Air Quality Standards") for six common criteria pollutants to protect sensitive populations and the environment: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), and particulate matter (PM). NAAQS further categorize particulate matter under two sizes—PM_{10} (diameter between 2.5 and 10 micrometers) and $PM_{2.5}$ (diameter of 2.5 micrometers or less). Table 3-1 presents the NAAQS for the six criteria pollutants.

Table 3-1 Ambient Air Quality Standards

Pollutant	Averaging Time	National Standard Concentration
Carbon Monoxide (CO)	8-hour	9 ppm (primary standard)
	1-hour	35 ppm (primary standard)
Lead (Pb)	Rolling 3-month average	0.15 µg/m^3
Nitrogen Dioxide (NO_2)	1-hour	100 ppb (primary standard)
	Annual	53 ppb (primary and secondary standard)
Ozone (O_3)	8-hour	0.070 ppm (primary and secondary standard)[(a)]
Particulate matter less than 2.5 µm ($PM_{2.5}$)	Annual	12 µg/m^3 (secondary) 15 µg/m^3 (secondary)
	24-hour	35 µg/m^3 (primary and secondary standard)
Particulate matter less than 10 µm (PM_{10})	24-hour	150 µg/m^3 (primary and secondary standard)
Sulfur Dioxide (SO_2)	1-hour	75 ppb (primary standard)
	3-hour	0.5 ppm (secondary standard)

Key: ppb = parts per billion; ppm = parts per million; µg/m^3 = micrograms per cubic meter. To convert ppb to ppm, divide by 1000.

(a) Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) ozone (O_3) standards additionally remain in effect in some areas.

Primary standards provide public health protection, including the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

Source: EPA 2018a

With respect to meeting NAAQS, the EPA designates areas that meet the standards as areas of attainment and areas that do not meet the standards as areas of nonattainment. Areas for which there is insufficient data to determine attainment or nonattainment, the EPA designates as unclassifiable. Areas that once did not meet the standards but now do meet the standards, the EPA calls maintenance areas; maintenance areas are under a 10-year monitoring plan to maintain the attainment designation status. States bear the primary responsibility for ensuring attainment and maintenance under NAAQS. Under Section 110 of the Clean Air Act and related provisions, States must submit, for EPA approval, State implementation plans (SIPs) that provide for the timely attainment and maintenance of the NAAQS.

In Florida, air quality designations are made at the county level. For the purpose of planning and maintaining ambient air quality under NAAQS, the EPA has developed air quality control regions. Air quality control regions are intrastate or interstate areas that share a common airshed. Turkey Point is located in Miami-Dade County, which is part of the EPA's Southeast Florida Intrastate Air Quality Control Region (40 CFR 81.49, "Southeast Florida Intrastate Air Quality Control Region"). This air quality control region consists of eight Florida counties: Broward, Miami-Dade, Indian River, Martin, Monroe, Okeechobee, Palm Beach, and St. Lucie. With respect to meeting NAAQS, EPA designates Miami-Dade County as unclassifiable/attainment or better than national standards for all criteria pollutants (40 CFR 81.310, "Florida"). The nearest designated nonattainment area (for the 2010 sulfur dioxide primary standard) is in Hillsborough County, FL, which is nearly 200 mi (320 km) from Turkey Point.

The Clean Air Act, Title V, "Permits," requires States to develop and implement an air pollution permit program. The FDEP regulates air emissions at Turkey Point under Title V air operation permits (FDEP 2018c, FDEP 2018g, FPL 2018f). Combined Turkey Point Units 1, 3, 4, and 5 are considered one facility for purposes of the Prevention of Significant Deterioration permitting program and Title V operating permits. However, FPL operates these units under two separate Title V permits: one for fossil fuel Unit 5 (Permit 0250003-030-AV) (Unit 1, which has been retired, was deleted from the permit upon its renewal in November 2018), and another for nuclear Units 3 and 4 (Permit 0250003-028-AV). The FDEP issued Title V Air Operation Permit 0250003-028-AV for Turkey Point Units 3 and 4 in April 2018, and this permit will expire in 2023 (FDEP 2018c). Table 3-2 lists permitted air pollutant emission sources and air permit specified conditions for Turkey Point Units 3 and 4.

Table 3-2 Permitted Air Emission Sources at Turkey Point Units 3 and 4

Equipment	Air Permit Condition
Five emergency diesel engines used to support plant equipment: • Industrial back-up instrument air compressors (2) • Backup service water feed system pump • 10-meter meteorological tower generator • Domestic wastewater system pump	PM, CO, and NO_x limits
One emergency diesel generator engine for the South Dade meteorological tower One emergency diesel fire pump	40 CFR Part 63, Subpart A, (NESHAP General Provisions) and 40 CFR Part 63, Subpart ZZZZ (NESHAP RICE)
Four diesel-engine emergency generators Two emergency diesel engines used to support plant equipment	Unregulated

Key: PM = particulate matter, NO_x = nitrogen oxides, CO = carbon monoxide, NESHAP = National Emission Standards for Hazardous Air Pollutants, RICE = reciprocating internal combustion engines

Source: FDEP 2018c

Table 3-3 shows annual emissions from permitted sources at Turkey Point Units 3 and 4. FPL operates diesel generators/engines at Turkey Point Units 3 and 4 only intermittently (usually during testing or during outages) as these are intended to be used to supply backup emergency power. According to the 2014 National Emissions Inventory, estimated annual emissions in tons per year for Miami-Dade County are approximately 3,650 (sulfur dioxide); 49,600 (nitrogen dioxide); 335,000 (carbon monoxide); 33,000 (particulate matter less than 10 microns); and 86,900 (volatile organic compounds) (EPA 2018b). Turkey Point Units 3 and 4 air emissions from permitted sources make up 0.05 percent or less of Miami-Dade County's total annual emissions. Greenhouse gas emissions from operation of Turkey Point Units 3 and 4 are discussed in Section 4.15.3 of this SEIS.

Table 3-3 Estimated Air Pollutant Emissions from Turkey Point Units 3 and 4

Emissions (tons/year)					
Year	SO_x	NO_x	CO	PM_{10}	VOCs
2012	1.5	16	2.1	1.8	0.8
2013	1.5	15	1.8	1.8	0.7
2014	1.8	19	2.4	2.2	0.9
2015	2.1	21	2.7	2.5	1.0
2016	1.7	17	2.0	2.0	0.8

Key: CO = carbon monoxide, NO_x = nitrogen oxides, SO_x = sulfur dioxides, PM_{10} = particulate matter less than 10 micrometers, VOC = volatile organic compounds
To convert tons per year to metric tons per year, multiply by 0.90718.

Source: FPL 2018f

The EPA promulgated the Regional Haze Rule to improve and protect visibility in national parks and wilderness areas from haze, which is caused by numerous, diverse air pollutant sources located across a broad region (40 CFR 51.308–51.309). Specifically, 40 CFR Part 81, Subpart D, "Identification of Mandatory Class I Federal Areas Where Visibility Is an Important Value," lists mandatory Federal areas where visibility is an important value. The Regional Haze Rule requires States to develop state implementation plans to reduce visibility impairment at Class I Federal areas. At Turkey Point, the nearest Class I Federal area is Everglades National Park, approximately 13 mi (21 km) west of Units 3 and 4 (FPL 2018f). Given Turkey Point Units 3 and 4's limited air emissions as presented in Table 3-3, there is little likelihood that ongoing activities at Turkey Point Units 3 and 4 during the subsequent license renewal term would adversely affect air quality and air quality-related values (e.g., visibility or acid deposition) in any Class I Federal areas.

3.3.3 Noise

Section 2.2.8.4 of NUREG–1437, Supplement 5 (the SEIS for the Turkey Point initial license renewal), describes general noise conditions at Turkey Point Units 3 and 4 (NRC 2002c). This information is incorporated here by reference. Section 2.10.2 of the EIS for the Turkey Point Units 6 and 7 combined licenses (NRC 2016a) also describes ambient noise conditions at the Turkey Point site. This information is also incorporated here by reference (NRC 2016a). No new and significant information about noise at the Turkey Point site was identified during the review of available information, including FPL's environmental report for the Turkey Point Units 3 and 4 subsequent license renewal (FPL 2018f), the site visit, or during the scoping process that would alter the discussion contained in the SEIS for Turkey Point's initial license renewal.

FPL conducted a noise survey for the Turkey Point Units 6 and 7 COL application environmental report in June 2008. The survey determined baseline ambient noise conditions near the proposed Turkey Point Units 6 and 7 site (including describing noise from Turkey Point Units 3 and 4) and identified sensitive offsite noise receptors. The nearest sensitive noise receptors included residences to the northwest, a daycare facility to the west, and Homestead Bayfront Park to the north (FPL 2014a).

In general, noise from the Turkey Point site can be detected under certain conditions by visitors in Biscayne National Park. Noise is most noticeable under calm wind conditions or when the wind is blowing lightly from the Turkey Point site to the park. Noise from Turkey Point Units 3 and 4 is generally not an issue at the nearest sensitive noise receptors west of the plant (a daycare facility) due to trees, other vegetation, and attenuation by distance.

3.4 Geologic Environment

This section describes the geologic environment of the Turkey Point site and vicinity, including landforms, geology, soils, and seismic conditions.

3.4.1 Physiography, Geology, and Soils

The land surface at Turkey Point and the area around it is practically flat. Elevations rise from sea level at the site to 10 feet (3 m) mean sea level (MSL) in the Homestead area 9 mi (14.5 km) to the west of Turkey Point. South Florida is underlain by gently dipping or flat-lying sedimentary rocks. In South Florida, these sedimentary rocks are more than 15,000 ft (4,572 m) thick. Limestone is the predominant rock found in the upper 5,000 ft (1,524 m) (FPL 2018f).

The limestone rock is divided into stratigraphic units based on geologic properties. The left side of Figure 3-7 identifies the stratigraphic units beneath Turkey Point down to a depth of greater than 3,030 feet (924 m). For each stratigraphic unit, the figure also includes a brief description of the rock characteristics (lithology), thicknesses, and depth.

The surficial material under Turkey Point consists of engineered fill. The surficial material within the Turkey Point site, which includes Turkey Point Units 1, 2, 3, 4, and 5, and the CCS, consists of either engineered fill, limestone, marl, or muck. Structures and roads are built on engineered fill or limestone. Any soils within the Turkey Point site consist of marl or muck. The muck consists of herbaceous organic material over limestone. The marl consists of loamy marine deposits over limestone (FPL 2018f, USDA 2017).

Some local depressions in the surface of the limestone bedrock occur at the Turkey Point site. These depressions are not sinkholes associated with the collapse of an underground solution channel, but rather potholes, which are surficial erosion or solution features. It is possible these features formed when sea levels were lower, and the rock surface was subjected to weathering and the effects of fresh water (FPL 2018f).

3.4.2 Economic Resources

Significant deposits of oil, gas, and other mineable resources are not known to exist beneath the Turkey Point site (NRC 2016a). Large quarries extract limestone rock in south Florida. This mining area is known as the Lake Belt Region. Limestone is found at or near land surface throughout the entire area. It is used as base material for roads and airport runways, as a construction aggregate, and in cement manufacturing (FDOT 2007, NRC 2016a, USGS 2018b, MDC 2017b). From Turkey Point, the nearest limestone quarrying is located 4.5 mi (7.2 km) west of the site (MDC 2017b). Another nearby mining area is the Atlantic Civil rock mine located about 10 mi (16 km) west of Turkey Point (NRC 2016a). Although the near-surface rock at Turkey Point is composed of limestone, the site's location near Biscayne National Park and its saltwater content makes it an unlikely choice for a future limestone mine.

3.4.3 Seismic Setting

Florida has a very small probability of experiencing damaging earthquake effects (FEMA 2018a). Based on historical or statistical seismic activity, Turkey Point is located in an inactive area for earthquakes and far from any recorded damaging shocks (FPL 2018f). Even so, the NRC evaluates the potential effects of seismic activity on a nuclear power plant in an ongoing process that is separate from the license renewal process. The NRC requires every nuclear plant to be designed for site-specific ground motions that are appropriate for its location. Nuclear power plants, including Turkey Point, are designed and built to withstand site-specific ground motion based on their location and the potential for nearby earthquake activity. The seismic design basis is established during the initial siting process, using site-specific seismic hazard assessments. For each nuclear power plant site, applicants estimate a design-basis ground motion based on potential earthquake sources, seismic wave propagations, and site responses, and then account for these factors in the plant's design. In this way, nuclear power plants are designed to safely withstand the potential effects of large earthquakes. Over time, the NRC's understanding of the seismic hazard for a given nuclear power plant may change as methods of assessing seismic hazards evolve and the scientific understanding of earthquake hazards improves (NRC 2014a). As new seismic information becomes available, the NRC expects that licensees will evaluate the new information to determine if safety systems at a plant require changes. Independently, the NRC also evaluates new seismic information and confirms that licensees appropriately consider potential changes in seismic hazards at the site.

SERIES	STRATIGRAPHIC UNIT		LITHOLOGY	TOP DEPTH (ft)	THICK-NESS (ft)	HYDRO-GEOLOGIC UNIT	TOP DEPTH (ft)
HOLOCENE	organic muck		organic soil and silt	0	3	Biscayne Aquifer	0 - 3
PLEISTOCENE	Miami Formation		sandy, oolitic limestone	3	25		
	Key Largo Limestone		well indurated, vuggy, coraline limestone	28	22		
	Ft Thompson Formation		poor/well indurated fossiliferous limestone	50	65		
PLIOCENE	Tamiami Formation		sand and silt with calcarenite limestone	115	105	Intermediate Confining Unit	140
MIOCENE	Hawthorne Group	Peace River Formation	silty calcareous sand and silt	220	235		
		Arcadia Formaion	calcareous wackestone with indurated limestone, sandstone and sand	455	555		
OLIGO-CENE	Suwannee Limestone		fine-grained limestone and dolomitic limestone	1010	245	Upper Floridan Aquifer (USDW)	1010
EOCENE	Avon Park Formation		fine-grained limestone and dolomite	1255	(~445)	Middle Floridan Confining Unit	1450
			permeable limestone	(~1700)	(~75)	APPZ (?)	(1700)
			fine-grained limestone and dolomite	(1775)	745	Middle Floridan Confining Unit	1930
	Oldsmar Formation		limestone, dolomitic limestone and dolomite	2580	450		
						Lower Floridan Aquifer	2915
			Boulder Zone	3030	>200	Boulder Zone	3030

Source: NRC 2016a

Figure 3-7 Geologic Stratigraphy and Major Aquifers Beneath the Turkey Point Site

3.5 <u>Water Resources</u>

This section describes surface water and groundwater resources at and around the Turkey Point site, with an emphasis on Turkey Point, Units 3 and 4.

At the Turkey Point site, surface water (including the area's freshwater canals, wetlands, and the adjoining Biscayne Bay) and groundwater are closely connected. This close relationship is attributable to the very high permeability of the underlying Biscayne aquifer, which permits water to move relatively freely between the surface and subsurface. As a result, the CCS is hydraulically connected to surface waters including Biscayne Bay via the groundwater pathway. These factors have been considered as part of the NRC staff's characterization of surface water and groundwater resources as presented in Sections 3.5.1 and 3.5.2 below, as well as in the staff's impact analyses for water resources presented in Section 4.5, "Water Resources."

3.5.1 Surface Water

Surface water encompasses all water bodies that occur above the ground surface, including rivers, streams, lakes, ponds, and man-made reservoirs or impoundments.

3.5.1.1 Surface Water Hydrology

Local and Regional Hydrology

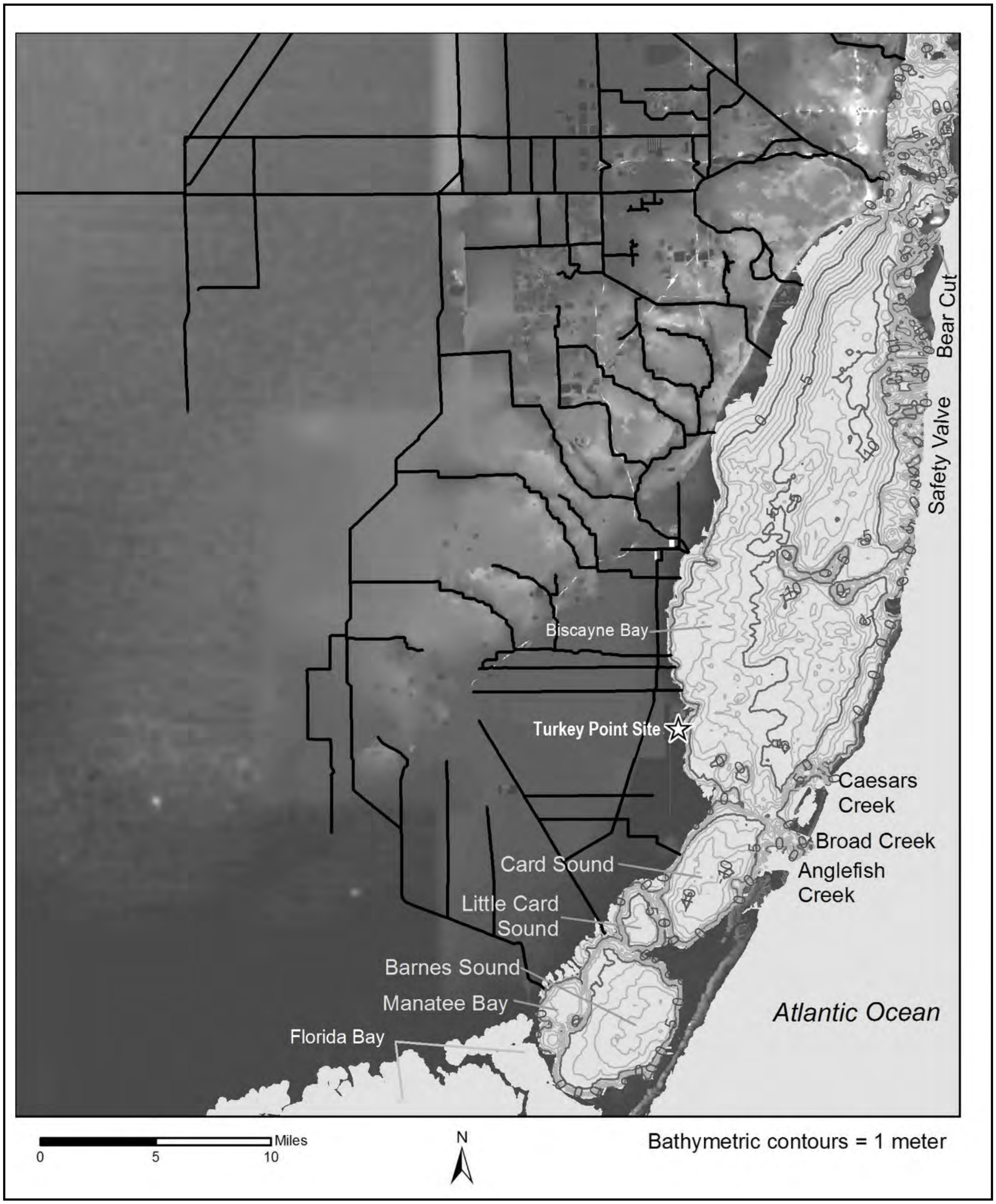
Biscayne Bay and the area around Turkey Point are part of the South Florida Hydrologic System (Figure 3-8). This encompasses a large area that includes the Everglades and Southern Florida coastal areas. Human activities have extensively influenced this system principally by population increases and land-use changes that resulted in the conversion of wetlands to agriculture and other uses. A significant contributor to these changes was the use of canals to drain land and redistribute surface water to other areas.

The South Florida Hydrologic System and how it has changed over time is described in the EIS for the Turkey Point Units 6 and 7 combined licenses (NRC 2016a) in Section 2.3.1.1 from pages 2-25 to 2-30, including Figures 2-8, 2-9, 2-10, and 2-11. The NRC staff incorporates the above text and figures into this SEIS by reference.

The regional surface water system west of Biscayne Bay encompasses the area east and south of the section of the Atlantic Coastal Ridge (ACR) near Biscayne Bay. Historically, various natural swales or glades and sloughs conveyed freshwater eastward to the coastal wetlands adjacent to Biscayne Bay and Card Sound. From there, freshwater discharged into Biscayne Bay and Card Sound either directly by surface water from the coastal wetlands or indirectly through groundwater. Under current conditions, manmade canals crisscross the landscape. These canals drain the land for agriculture and urban use, provide flood control, and discharge their freshwater into Biscayne Bay and Card Sound (NRC 2016a).

The canals also have an indirect impact on groundwater resources. Draining the land causes the water level in near-surface aquifers to drop. This in turn has contributed to the inland movement of groundwater that contains salt (saltwater intrusion) from Biscayne Bay and Card Sound (see Section 3.5.2). The canals contain control structures to prevent the inland movement of surface water from Biscayne Bay and Card Sound. During the wet season (typically, the months of June – October), coastal control structures periodically open and discharge freshwater to Biscayne Bay. During the dry season, coastal control structures generally remain closed to maintain relatively high water levels along the coast and prevent saltwater intrusion within near-surface aquifers. (USGS 2001).

The Turkey Point Units 6 and 7 COL EIS (NRC 2016a) in Section 2.3.1.1 (on Pages 2-31 and 2-32, including Figure 2-12) describes the regional surface water system west of Biscayne Bay and how it has changed over time. The NRC staff incorporates this text and figure into this SEIS by reference.



Source: Modified from NRC 2016a

Figure 3-8 Turkey Point Site, Biscayne Bay, Card Sound, and Regional Canals

Biscayne Bay and Card Sound

Biscayne Bay is located east of and adjacent to the Turkey Point site. (Figure 3-8). Card Sound is located to the southeast of the site. Both are shallow bays that formed in depressions in the limestone bedrock. The bays are bounded on the east by coral keys that are formed from wave-resistant limestone. Both Biscayne Bay and Card Sound are in direct contact with the Biscayne aquifer as the limestone rock of the aquifer forms the bottom of both bays (see Section 3.5, “Groundwater Resources”) (NPS 2015a, NPS 2012, NRC 1972, USGS 2008b).

Biscayne Bay and Card Sound are separated by Cutter Bank which is an underwater topographic rise (mud bank) (NRC 1972). Near the Turkey Point site, both Biscayne Bay and Card Sound are shallow bays. Within Biscayne Bay, over most of the distance between the Turkey Point site and the coral keys, the depth of the water generally ranges from 2 to 6 ft (0.6 to 1.8 m), reaching a maximum depth of about 7 ft (2.1 m). Within Card Sound, over most of the distance between the Turkey Point site and the coral keys, the depth of the water generally ranges from 4 to 9 ft (1.2 to 2.7 m), reaching a maximum depth of about 10 ft (3 m) (NOAA 2018a). Both Biscayne Bay and Card Sound are connected to the Atlantic Ocean by gaps between the coral keys. However, near the Turkey Point site, the enclosed configuration of the coral keys has isolated much of Biscayne Bay and Card Sound from direct marine influence (USGS 2008b).

The hydrology and hydrodynamics of Biscayne Bay and Card Sound are influenced by several factors: (1) tidal exchange of marine waters from the Atlantic Ocean, (2) surface and groundwater inflows of freshwater, (3) precipitation, and (4) evaporation (NRC 2016a). All of these factors also influence the salinity in Biscayne Bay and Card Sound. During the wet season, precipitation decreases the salinity in the bay and the sound. During dry periods, evaporation increases salinity within the bay and the sound, and salinities can become hypersaline (NRC 2016a).

The construction of drainage canals on the mainland has also impacted salinity in the bay and sound. This impact is greatest in the near-shore areas adjacent to the mainland. Prior to the construction of drainage canals, freshwater entered the bay and sound from the mainland by widespread sheet flow and groundwater discharge. This provided a more uniform and continuous supply of freshwater to the bay and the sound than the present situation. With the construction of drainage canals, freshwater was less uniformly distributed as the canals discharged freshwater at discrete locations. The result is that areas near canal discharge locations have less saline water than areas farther away from the discharge locations (NRC 2016a).

Another way that drainage canals have impacted salinity in the bay and the sound is through seasonal differences in the amount of canal discharge. The canals generally discharge the most freshwater into the bay and sound during wet times of the year and the least during dry periods. As a result, salinity concentrations throughout the year in the bay and sound are more variable in time and space than prior to the construction of drainage canals (NRC 2016a). In addition, modeling studies suggest that drainage canals may intercept surface runoff thereby preventing that runoff from infiltrating and raising the groundwater table elevation (USGS 2012). The reduced infiltration may result in reduced groundwater discharge into Biscayne Bay and Card Sound.

Around the Turkey Point site, drainage canals discharge to Biscayne Bay north of the site and to Card Sound south of the site. The Turkey Point site occupies an area of former sheet flow that discharged into the bay. Since 1900, the hydrology of the Southern Florida Coastal Plain ecoregion, within which the Turkey Point site is located, has been highly altered by human activity to support agriculture and urban development. Under the Central and Southern Florida Flood Control Project, which was authorized by Congress in 1948, the government constructed a series of canals for flood control, water supply and retention, irrigation, and transportation. These canals drained the land, which resulted in reduced sheet flow to the Biscayne Bay and Card Sound. Development of the Turkey Point site also blocks sheet flow from reaching Biscayne Bay (NRC 2016a). One aim of the Everglades Mitigation Bank is to restore historic sheet flow south of the Turkey Point site through the construction and operation of culverts (FPL 2018f).

Pollution from human activities also impacts the water quality of Biscayne Bay. Sections of the shoreline of Biscayne Bay are highly developed. The southern end of Biscayne Bay and Card Sound is less urbanized than the northern section of Biscayne Bay. Pollutants can potentially enter Biscayne Bay from multiple sources, including boats, canals, quarrying operations, landfills, military operations, a sewage-treatment plant, urban and agricultural runoff, and submarine groundwater springs (USGS 2008b).

The inflow of fresh water that is high in nutrients thus appears to be a significant issue affecting the ecosystem in Biscayne Bay. The EIS for the Turkey Point Units 6 and 7 combined licenses (NRC 2016a) in Section 2.3.1.1 (on pages 2-33 through 2-38, including Figures 2-14, and 2-15, and Table 2-8) describes the hydrology and hydrodynamics of Biscayne Bay. The NRC staff incorporates the above text and figures into this SEIS by reference.

Management of Biscayne Bay and Card Sound Water Quality

The Florida legislature has designated Biscayne Bay and Card Sound, including Biscayne National Park, as Outstanding Florida Waters. This affords these waters the highest water quality protections in the State (NRC 2016a; Robles, et al 2005; NPS 2012). The FDEP cannot issue new permits for direct discharges to designated Outstanding Florida Waters that would lower ambient (existing) water quality and may not issue permits for indirect discharges that would significantly degrade a nearby waterbody designated as an Outstanding Florida Water (FDEP 2017a). Florida water quality rules provide exceptions for permits that were issued prior to the effective date of an Outstanding Florida Waters designation (see FAC 62-4.242(2)(a)).

Card Sound and the north half of Biscayne Bay are within the Biscayne Bay Aquatic Preserve. The FDEP's Office of Coastal and Aquatic Managed Areas manages this preserve (NRC 2016a). One of the management goals is to protect and enhance the waters of the preserve so the public may enjoy the traditional recreational uses of those waters such as swimming, boating, and fishing. No wastes or effluents which substantially inhibit the accomplishment of these purposes can be discharged into the preserve (Florida Statute 258.397).

The rest of Biscayne Bay lies within Biscayne National Park (Park), including the Biscayne Bay waters adjacent to the Turkey Point site (NRC 2016a). Biscayne National Park was established "in order to preserve and protect for the education, inspiration, recreation, and enjoyment of present and future generations a rare combination of terrestrial, marine, and amphibious life in a tropical setting of great natural beauty" (USGS 2008b). The park is managed by the U.S. National Park Service. In 2015, a Final General Management Plan was completed for the Park. This plan contains strategies on the management of the resources and activities within the Park to best fulfill Biscayne National Park's mission. It can be found under reference NPS 2015a.

Relationship of Water Quality to Biologic Communities in Biscayne Bay and Card Sound

The southern coastal system of the State of Florida is a contiguous network of coastal wetlands and estuaries that wrap around the southern end of the Florida peninsula from Biscayne Bay on the southeastern coast to the Ten Thousand Islands area on the Upper Southwest Coast. The loss of freshwater wetlands upstream, and increasing human alteration of the regional hydrology for flood protection and societal water supply, have decreased the flow of freshwater into the southern coastal systems. This has altered salinity in the shallow coastal waters and degraded habitat for valuable estuarine fish and wildlife. From 2012–2017, the inconsistent delivery of freshwater combined with periods of significant drought, hurricanes and sea level rise, have continued to impact the biologic communities of the southern coastal region (RECOVER 2019).

The Restoration Coordination and Verification program reported in its 2019 Everglades System Status Report that a local drought in 2014 and 2015 and associated elevated salinity in combination with reduced freshwater flow negatively impacted some aquatic species and submerged aquatic vegetation in Biscayne Bay and Florida Bay (Figure 3-8). Salinity measurements over the past decade indicate that freshwater flows into Biscayne Bay's southwestern perimeter lack both volume and duration to significantly improve the biological communities that reside along the shoreline and in its vicinity (RECOVER 2019).

Nutrients, particularly macronutrients such as nitrogen and phosphorous are key water quality indicators for Biscayne Bay. The Turkey Point site is located next to the South Central Mid-Bay Region of Biscayne Bay. The State of Florida has established numerical nutrient criteria for this region of 0.007 mg/L for total phosphorous, 0.35 mg/L for total nitrogen, and 0.2 micrograms/L for chlorophyll-a. These criteria are expressed as annual geometric means and are not to be exceeded more than once in a 3-year period (Figure 3-9) (FDEP 2018e).

The chlorophyll-a concentration in the surface water is related to the concentration of algae in the water column. Chlorophyll-a concentrations, in combination with a nutrient analysis, can be used to assess the health of Biscayne Bay. For example, this information can be used to monitor for algal blooms or eutrophic conditions and to identify sources of excess nutrients (BBWW 2019).

As previously mentioned, nutrients can enter Biscayne Bay and Card Sound from several sources and pathways, including urban runoff (e.g., streets, lawns), animal manure run off, sewage, leaking septic tanks, fertilizer, and erosion of land that is rich in phosphates and nitrates (BBWW_2019). Notably, storm events are often accompanied by high-volume discharges from regional canals before and after a storm. These discharges often contain high levels of nutrients (MDC 2019b).

In September 2005, a phytoplankton bloom formed in a series of shallow lagoons between Florida Bay and Biscayne Bay. The bloom lasted 3 years and spanned an area from Duck Key in Florida Bay to Card Sound in southern Biscayne Bay. Some scientists have hypothesized that the bloom was triggered by the occurrence of three hurricanes over a 3-month period (Katrina, Rita, and Wilma) combined with a major construction project on an adjacent causeway (Millette et al. 2018). The bloom had the largest impact in the region of Manatee Bay, Blackwater Sound, Long Sound, and Barnes Sound. The highest peak in chlorophyll-a concentrations (>20 microg/L) occurred in Blackwater Sound and Barnes Sound. It is unknown if the system fully shifted back to being dominated by benthic production after the bloom (Millette et al. 2018). To date, seagrass recovery is minimal and chlorophyll-a concentrations remain elevated (MDC 2019b).

Since 2008, a bloom of green macroalgae has persisted in northwestern Biscayne Bay. The bloom displaced once-healthy seagrass beds. The bloom is in an area of high levels of dissolved nutrients, as well as the presence of sucralose, which is an indicator of human waste water. In addition, an incipient bloom of green macroalgae was detected in the Deering Estate area along the western shore of central Biscayne Bay (RECOVER 2019).

Miami-Dade County has monitored seagrass and water quality in Biscayne Bay for over 30 years. Since 1985, the monitoring program has documented largely stable seagrass throughout the Bay, with only one seagrass loss event documented prior to 2005, and no significant phytoplankton or macroalgal blooms. However, since 2005, there has been a succession of algal blooms and seagrass losses with two significant phytoplankton blooms and a macroalgal bloom (RECOVER 2019).

The level of seagrass abundance over the past 10 years in western Biscayne Bay has had high seasonal fluctuations but is reasonably stable and largely unaffected by large-scale disturbances (RECOVER 2019). However, the parts of the bay receiving waters from some of the most nutrient-rich canals include basins where seagrass die-off has occurred. Miami-Dade County reports that over the past decade, three areas have experienced significant seagrass losses (Figures 3-10 and 3-11).

1) The Barnes Sound and Manatee Basins experienced a decrease in seagrass of approximately 93 percent.

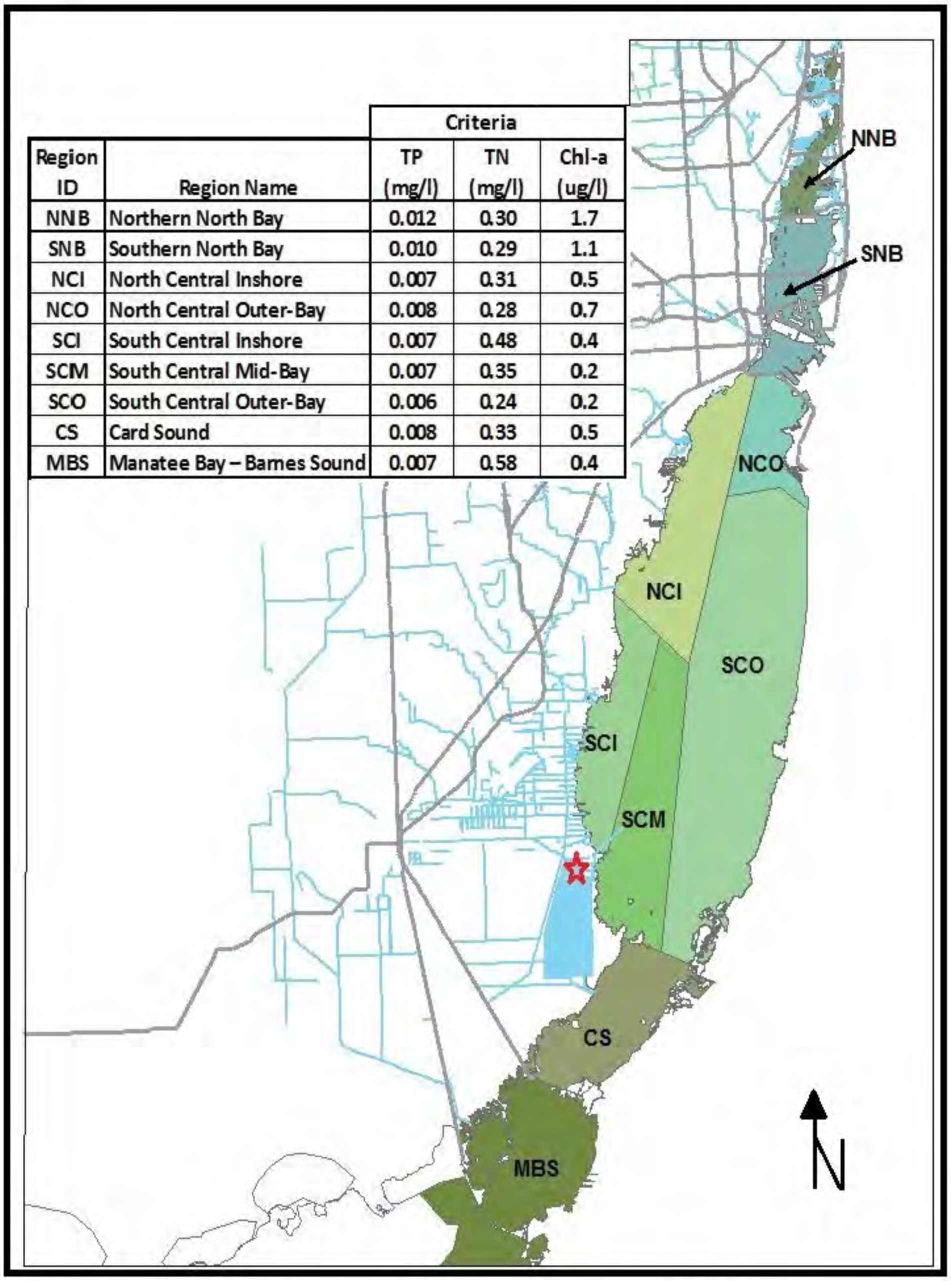
2) The central portion of Biscayne Bay near Coral Gables experienced a decrease of 85 percent.

3) Basins north of the Rickenbacker Causeway experienced a decrease of 66 to 89 percent (MDC 2019b).

Miami-Dade County reports that chronic low-level nutrient loading and/or acute, pulsed nutrient loading is likely linked to seagrass loss in Biscayne Bay. The County is concerned that excess nutrients can lead to a shift from a seagrass-dominated habitat with clear water, low turbidity, and low levels of algae in the water column to an algae-based ecosystem that is turbid and contains reduced-quality habitat for fish (MDC 2019b).

In the 2019 Everglades System Status Report, the Restoration Coordination and Verification program states that "[l]ong-term evaluations have shown increasing trends in chlorophyll-a, total phosphorus, and total nitrogen. Looking ahead, the future of Biscayne Bay's submerged aquatic vegetation appears bleak. Given the large areas that have been impacted by seagrass losses, with limited to no recovery and the shift to increased chlorophyll-a that follows those losses, coupled with the long-term increasing trends in nutrients and chlorophyll-a, it is likely that recovery from seagrass losses will remain limited and the Bay is at risk of further declines in the submerged aquatic vegetation community" (RECOVER 2019).

This SEIS contains additional information (see Section 3.7.4, "Biscayne Bay and Card Sound Semiannual Monitoring") about seagrass habitat monitoring that is conducted in areas adjacent to the Turkey Point site. This monitoring is ongoing and is being carried out by FPL in connection with the FDEP Consent Order and the Consent Agreement with Miami-Dade County.



Region ID	Region Name	Criteria TP (mg/l)	TN (mg/l)	Chl-a (ug/l)
NNB	Northern North Bay	0.012	0.30	1.7
SNB	Southern North Bay	0.010	0.29	1.1
NCI	North Central Inshore	0.007	0.31	0.5
NCO	North Central Outer-Bay	0.008	0.28	0.7
SCI	South Central Inshore	0.007	0.48	0.4
SCM	South Central Mid-Bay	0.007	0.35	0.2
SCO	South Central Outer-Bay	0.006	0.24	0.2
CS	Card Sound	0.008	0.33	0.5
MBS	Manatee Bay – Barnes Sound	0.007	0.58	0.4

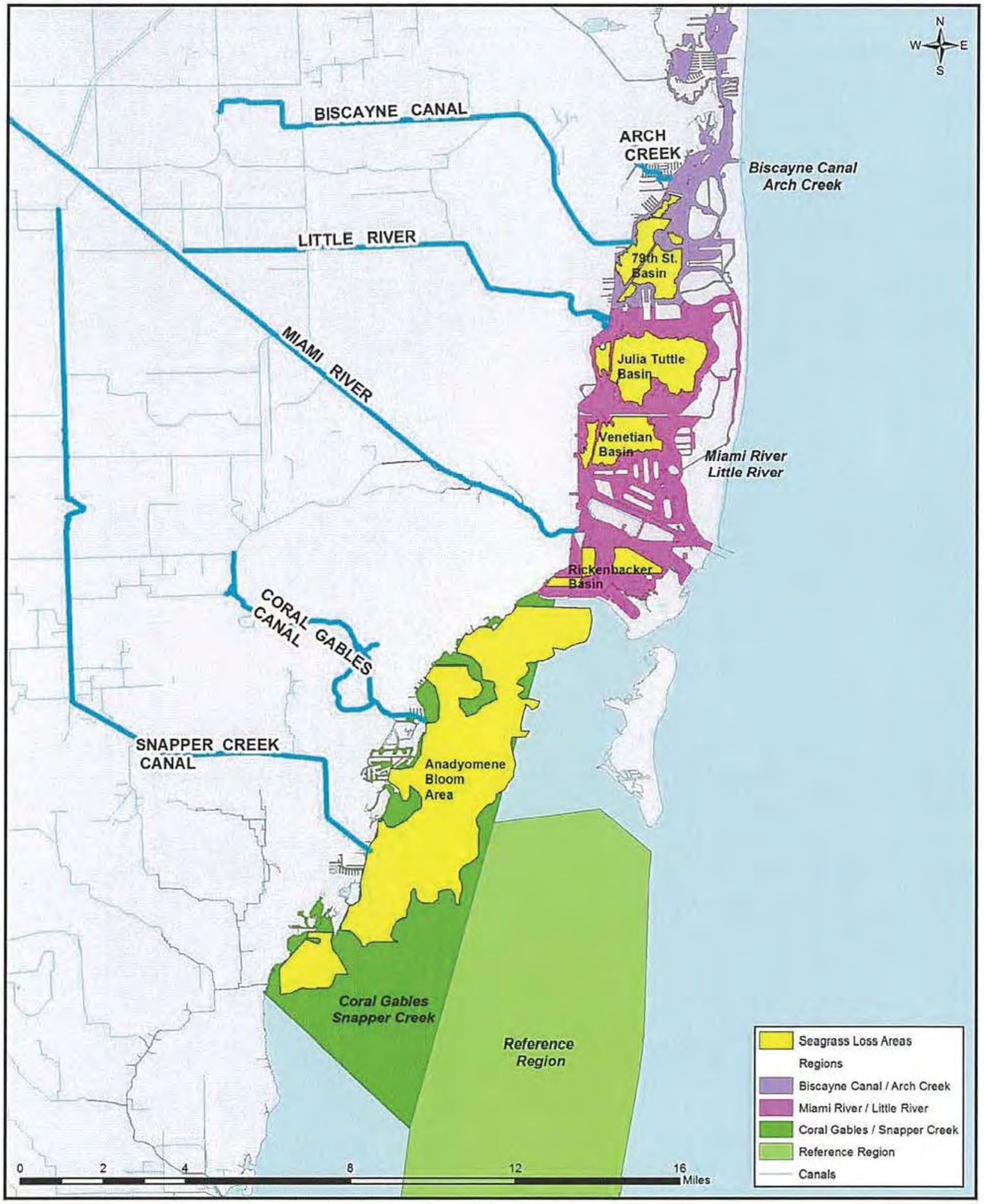
☆ Turkey Point Site

Legend

TP	Total Phosphorous
TN	Total Nitrogen
Chl-a	Chlorophyll-a

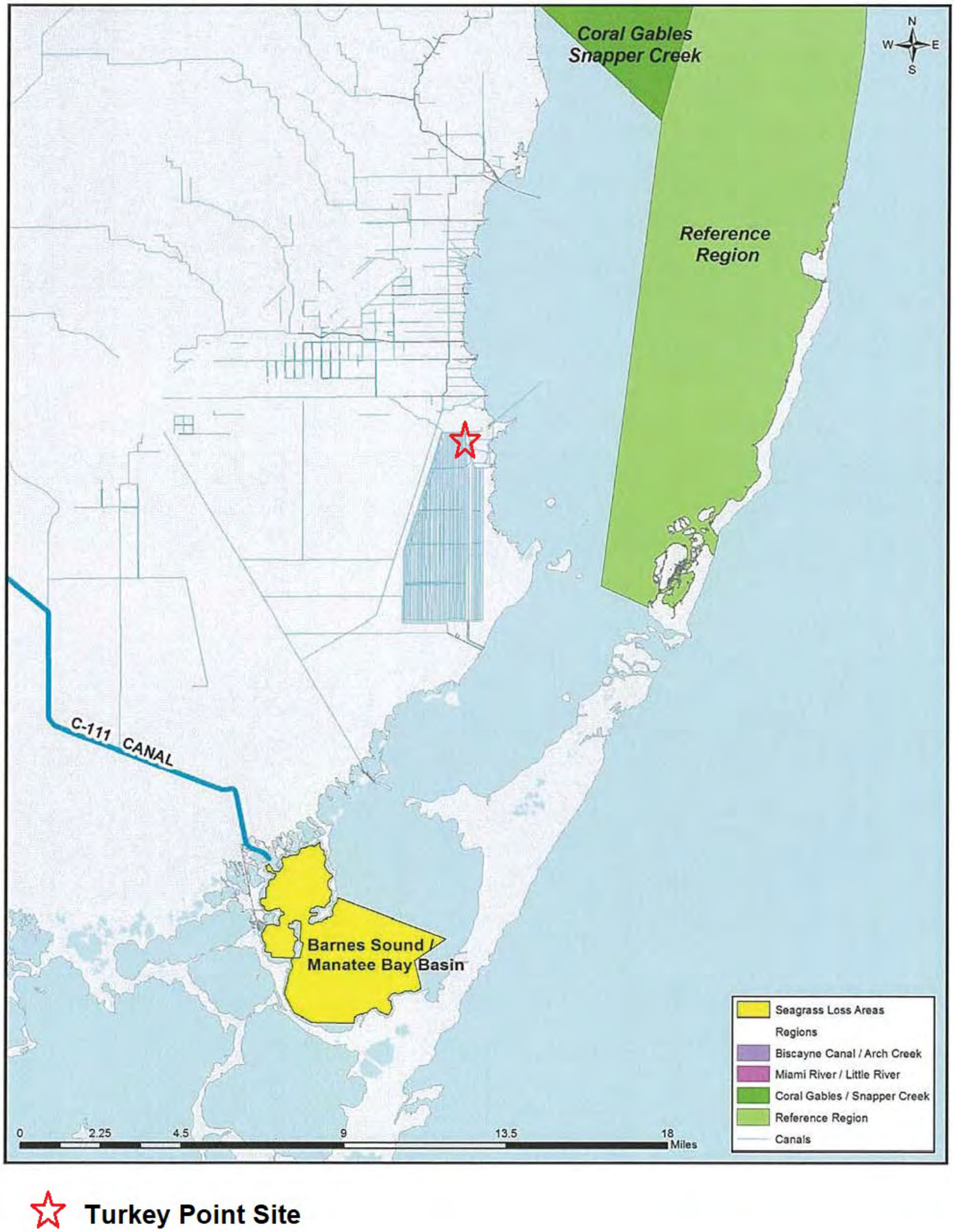
Source: Modified from RECOVER 2014

Figure 3-9 Numeric Surface Water Criteria for Regions of Biscayne Bay



Source: Modified from MDC 2019b

Figure 3-10 Sea Grass Loss Areas from 2005 to 2018 by Regions North Half of Biscayne Bay



Source: Modified from MDC 2019b

Figure 3-11 Sea Grass Loss Areas from 2005 to 2018 by Regions South Half of Biscayne Bay

Marshland and Mangrove Areas Adjacent to the Turkey Point Site

The Turkey Point site is adjacent to marshland outside its northwest, west, and southern boundaries and a significant portion of its eastern boundary. Surface water within the marshland lies on top of muck, which in turn lies on top of the Biscayne aquifer. The surface water hydrology of the marshlands is driven by rain, surface water runoff, freshwater canal overflows, and saltwater from Biscayne Bay and Card Sound (tides, storms, groundwater) (FPL 2016a). Mangrove areas are located adjacent to Biscayne Bay. Soil porewater samples from the marshland muck show that the marshlands adjacent to and west of the Turkey Point are filled with freshwater, whereas marshlands adjacent to and south and east of the Turkey Point site are filled with brackish water. The marshlands become more brackish the closer they are to Biscayne Bay or Card Sound (FPL 2014b, 2016a, 2017a).

Canals Adjacent to the Turkey Point Site

A network of drainage canals provides freshwater and drainage to southeastern Florida (FPL 2018f). Some of these canals can be found near the Turkey Point site (Figure 3-4). The CCS does not have a surface water connection with any of these canals. North of the Turkey Point site, the Florida City Canal runs east to west and discharges fresh water into Biscayne Bay (FPL 2014a). West of the Turkey Point site, the L-31E Canal contains freshwater and runs northeast to southwest (FPL 2016a).

South of the Turkey Point site, the S-20 Canal and the Sea Dade Canal remnant canal run east to west. The S-20 Canal runs outside the southeast corner of the CCS. It is connected to the L31E Canal by a flow control structure on its western end and connects to Card Sound south of the site. The S-20 Canal contains fresh water when water is being discharged through it and marine water when there is no fresh water discharge through it. The Sea Dade Canal once connected to the S-20 Canal; however, under the provisions of the Everglades Mitigation Bank program, the Sea Dade Canal was plugged off from the S-20 Canal. The Sea Dade Canal is currently a remnant, dead-end canal with no connection to either the Card Sound or Biscayne Bay. The Card Sound remnant canal is also adjacent to the CCS. It runs in a generally north-south direction and dead ends against the outside of the CCS. It contains marine water and connects to Card Sound.

Potential for Flooding at the Turkey Point Site

The NRC evaluates the potential effects of floods on a nuclear power plant as a safety issue in a separate and distinct process, outside of the license renewal process. The NRC addresses flood hazard issues on an ongoing basis at all licensed nuclear facilities (NRC 2013a). The NRC requires every nuclear power plant to be designed for site-specific floods, to assure protection for safety-related equipment and facilities. As new information on flood hazard issues becomes available, the NRC expects each licensee to evaluate the new information to determine if its plant requires changes to protect its safety systems. The NRC also evaluates new information important to flood projections and independently confirms that a licensee's actions appropriately consider potential changes in flooding hazards at the site.

For structures that are important to the safe operation of the nuclear units, the NRC requires that they be designed and operated in consideration of potential flooding. The NRC does not have similar requirements for nonsafety-related structures. At the Turkey Point site, such nonsafety-related structures include, for example, office buildings, the Unit 5 cooling towers, and the CCS. Nonsafety-related structures, however, may be subject to additional requirements if their failure could impact a safety-related system, structure, or component.

FPL recently completed a new flood analysis in connection with the NRC's oversight of the current operating licenses at Turkey Point Units 3 and 4. For the current licensed period of operation, FPL submitted its analysis to the NRC in a process that was separate from subsequent license renewal. After extensive review, the NRC approved this flood analysis on June 29, 2017 (NRC 2017b)

The new flood analysis for Units 3 and 4 contained a maximum storm surge projection of 19.1 ft (5.8 m). In a separate and independent analysis, the maximum storm surge projection for the design of proposed Units 6 and 7 at the Turkey Point site was 24.8 ft (7.6 m). In the analysis for Units 3 and 4, FPL used a detailed model that contained more realism than the less detailed deterministic model used by FPL for Units 6 and 7. To account for the less detailed evaluation, more conservative assumptions were incorporated into the analysis for the Units 6 and 7 model. For example, the assumptions in the model used for Units 6 and 7 included (1) a hypothetical hurricane with an intensity much greater than has ever been observed in the Atlantic Ocean and (2) an additional 20 percent added margin to the final computed storm surge water level. This resulted in a higher maximum storm surge projection.

Class 1 structures on the Turkey Point site are flood protected up to a minimum elevation of 20 feet (6.1 m) MSL. With the exception of the intake cooling water (ICW) pumps, which are protected to 22.5 feet (6.9 m) MSL, components vital to safety are protected against flood tides and waves up to 22 feet (6.7 m) MSL on the east side of Turkey Point (FPL 2018f).In an emergency, if Turkey Point Units 3 and 4 are unable to obtain cooling water from the CCS, the reactors would be placed in a safe shutdown mode. While in this mode, the reactors would still need to be cooled, but would require much less cooling water. Should this situation ever occur, water for cooling would be supplied from a protected well that obtains brackish water from the Upper Floridan aquifer.

As part of the NRC's subsequent license renewal review for Turkey Point Units 3 and 4, a safety review is conducted in accordance with the requirements of 10 CFR Part 54 (Requirements for renewal of operating licenses for nuclear power plants). In this regard, FPL committed to develop and implement an aging management program for the CCS to protect against a structural failure of the cooling canals that could impact safety-related equipment. FPL stated in its license renewal application, that the aging management program for the CCS will be commensurate with Regulatory Guide 1.12, "Criteria and Design Features for Inspection of Water-Control Structures Associated with Nuclear Power Plants" (NRC 2016e). The aging management program proposed by FPL for the CCS will include these elements:

1) visual inspections performed at least once every 5 years
2) special inspections performed following major events such as hurricanes
3) photographs to document findings and trend degradation
4) the inspections will be consistent with the 10 elements of NUREG-2191, Section XI.S7, "Inspection of Water-Control Structures Associated with Nuclear Power Plants" (NRC 2017c)
5) monitored parameters include erosion and degradation

As part of the State of Florida's regulatory process, the FDEP is currently conducting a renewal process for FPL's national pollutant discharge elimination system (NPDES) permit for Turkey Point, including Units 1-5 (FDEP 2018f). The draft permit contains requirements for impoundment design, construction, operation, and maintenance. While the NRC aging management program is concerned with the safe operation of Units 3 and 4, the requirements of the State's draft NPDES permit address potential impacts on the environment from structural failure of the CCS. Some of the requirements of the draft NPDES permit are as follows.

- All impoundments used to hold or treat wastewater and stormwater, including the CCS, shall be designed, constructed, operated, and maintained to prevent the discharge of pollutants to waters of the State, except as authorized under the permit.

- Design, construction, operation, and maintenance of any impoundment shall be in accordance with all relevant State and Federal regulations and shall be certified by a qualified, State-registered professional engineer and permitted and inspected by the appropriate agency prior to use. When practicable, piezometers or other instrumentation shall be installed to aid monitoring of impoundment integrity

- In addition to other regular maintenance activities conducted for the CCS, the perimeter berms and slopes shall be maintained to protect the structural integrity. This may include removal of trees greater than 4 inches in diameter.

- The CCS periphery including the three small dams (Hotel 2, Turtle Point Canal, and the Cellular Cofferdam) shall be inspected above and below the surface waterline for the entire perimeter at a minimum of once every 5 years by an independent qualified, State-registered professional engineer. The three dams and all other aspects of the perimeter impoundments shall be inspected annually by a qualified, State-registered professional engineer. All impoundments other than the CCS shall be inspected at least monthly by qualified personnel. The term "qualified" means having successfully completed the Mine Safety and Health Administration Qualification for Impoundment Inspection course in addition to the Annual Retraining for Impoundment Qualification, or equivalent qualifications. Additional inspections by qualified personnel shall be done within 7 days after large or extended rain events (i.e., 10-year, 24-hour precipitation event).

- Inspections shall at a minimum include observations of dams, including the three dams (Hotel 2, Turtle Point Canal, and the Cellular Cofferdam) of the CCS, dikes and toe areas for erosion, corrosion, cracks or bulges, seepage, wet of soft soil, changes in geometry, the depth and elevation of the impounded water, sediment or slurry, freeboard, changes in vegetation such as overly lush, dead, or unnaturally tilted vegetation, and any other changes that may indicate a potential compromise to impoundment integrity.

- To monitor function of the cathodic protection system, suggested operation and maintenance practices described in the Operation and Maintenance Manual accompanying these devices shall be followed.

- The findings of each inspection shall be documented in a written annual inspection report.

- Within 24 hours of discovering changes that indicate a potential compromise to the structural integrity or the efficient operation of the CCS, the permittee shall begin procedures to remediate the problem. Adherence to the six components of the Turkey Point Cooling Canal System Thermal Efficiency Plan dated December 14, 2016, shall be incorporated into the facility's best management practices.

- Within 5 days of discovering any changes in the CCS that indicate a potential compromise to the structural integrity or operation, the permittee must notify the FDEP in writing, describing the findings of the inspection, corrective measures taken since discovery of the change, other planned corrective measures and the expected outcomes. Failure to do so will be a violation of this permit.

- Other issues that may have long-term impacts on integrity, such as trees growing on the CCS or banks or vegetation blocking canals or spillways, shall be cleared within 30 days of first observation.

- During routine operational and maintenance activities around the CCS, periodic observation of the perimeter should continue reporting noted defects.

- The permittee shall submit an annual report of all impoundment inspections and maintenance activities, including corrective actions made in response to inspections, summarizing findings of all monitoring activities including the annual thermal efficiency evaluation of the CCS, remediation measures pertaining to the structural integrity, design, construction, and operation and maintenance of the CCS, and all other activities undertaken to repair or maintain the CCS and other impoundments.

- Unauthorized releases or spills reportable to the State Watch Office shall also be reported to the FDEP within 24 hours from the time the permittee becomes aware of the discharge.

- If, after providing notice, the permittee determines that a reportable unauthorized release of spill has migrated outside the property boundaries of the installation, the permittee must provide an additional notice to the FDEP that the release has migrated outside the property boundaries within 24 hours after its discovery of migration outside of the property boundaries.

The NRC's oversight process will require monitoring of CCS structural integrity over the duration of the subsequent license renewal term. As previously discussed, the new NPDES permit will likely require FPL to report any degradation of the CCS to State regulatory agencies. Acting within their respective jurisdictions, these agencies should be able to take timely regulatory actions to require that the structural integrity of the CCS be maintained.

Tidal flooding during hurricanes is the major flooding concern at the Turkey Point site. The highest tide nearest the site was recorded in September 1965 during Hurricane Betsy and reached an elevation of 10.1 ft (3.1 m) MSL. The station where the measurement was made is located north of Palm Drive on the Florida City Canal, approximately 2.3 mi (3.7 km) west of the shoreline. In 1965, debris marks from the flood tide associated with Hurricane Betsy were seen at an elevation of approximately 10 ft (3 m) MSL at the Turkey Point site (FPL 2018f).

Because of the low flat terrain, tidal floodwaters in the Turkey Point area can move inland several miles and can cover large areas. Construction of flood control projects in the area have reduced the possibility of tidal floodwaters reaching agricultural and populated areas. The L-31E Canal, which is not part of the Turkey Point site, is designed to provide flood protection to properties further west. This canal is located west of the Turkey Point site and generally runs from southwest to northeast. It includes a levee with a crest elevation of 7 ft (2.1 m) MSL. However, it is not designed to prevent flooding from severe hurricanes with tidal flooding. Based on published storm-tide frequency studies, it is estimated that a 7 ft (2.1 m) tide may occur once every 20 to 25 years near the Turkey Point site (FPL 2018f).

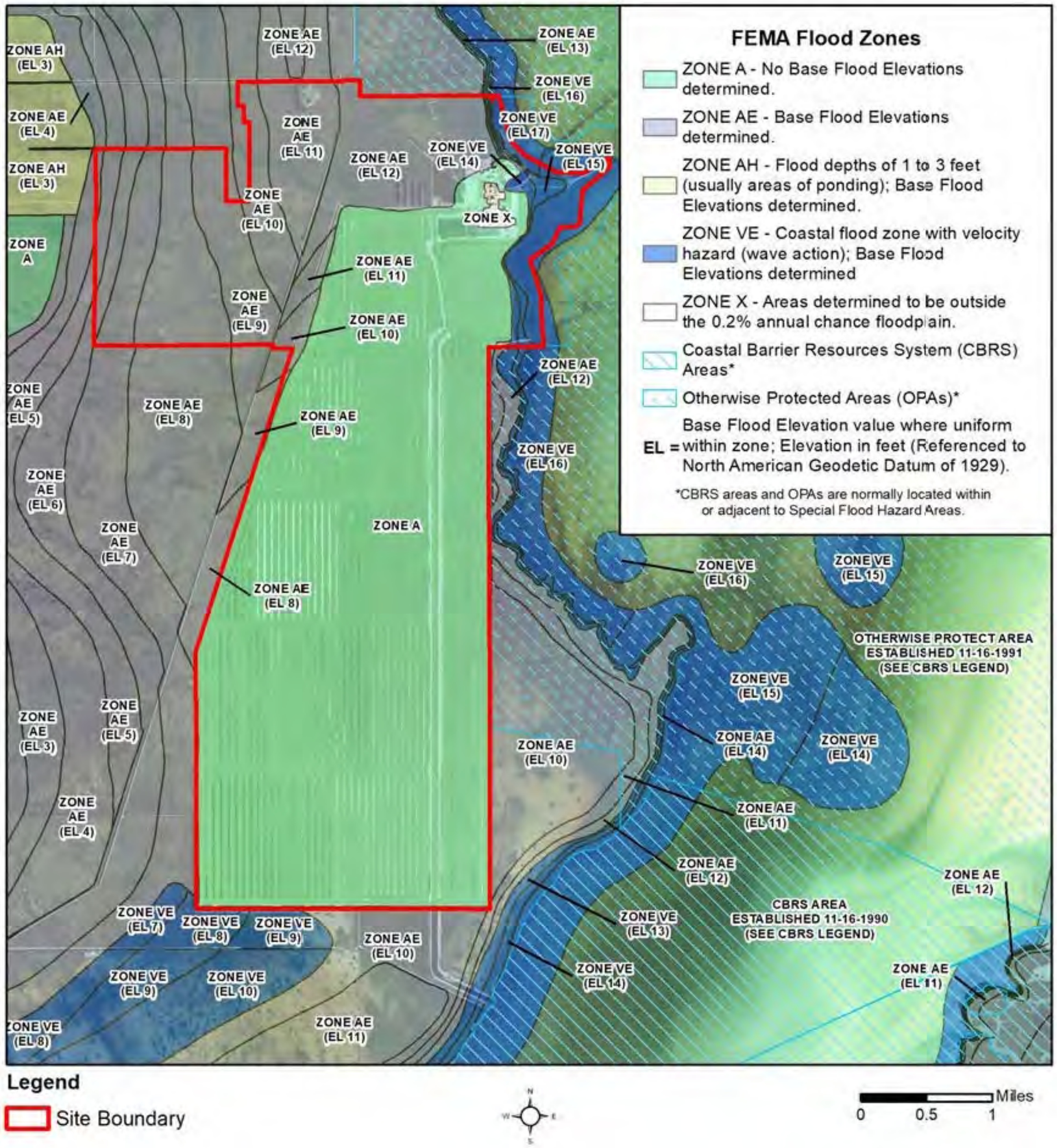
The Federal Emergency Management Agency (FEMA) has prepared flood zone maps that cover the Turkey Point site and surroundings (Figure 3-12). Except for Units 3 and 4, FEMA maps most of the Turkey Point property and the surroundings as Zone A (FPL 2018f). A Zone A area has a 1-percent annual chance of flooding within any single year (FEMA 2014). The water depth of a flood with a 1-percent chance of annual flooding in any single year is called the base flood (FEMA 2018b).

Within the Turkey Point site, FEMA designates a small area near the shoreline along the northeastern property line as within the coastal flood zone with hazardous wave action, and with base flood depths of 14 to 17 feet (4.3 to 5.2 m) (NAVD88). FEMA designates approximately 27 percent of the Turkey Point property as within the coastal flood zone with base flood depths of 11 to 14 ft (3.4 to 4.3 m). However, the remaining 70 percent of the site where the canal system is located has no base flood elevations determined by FEMA. Inland from and just outside and along the western boundary of the CCS, base flood depths range from 8 to 11 ft (2.4 to 3.4 m) (FPL 2018f).

The increased potential for future coastal flooding based on climate change projections is discussed in Section 4.15.3.2 (Climate Change) of this SEIS.

3.5.1.2 Surface Water Consumption

Surface water resources are not consumed by Turkey Point operations. All water consumed by Turkey Point is derived from groundwater resources.



Source: From FPL 2018f

Figure 3-12 FEMA Flood Zones Map of the Turkey Point Property

3.5.1.3 Surface Water Discharges

Operations at Turkey Point do not discharge to surface water bodies outside of the Turkey Point site. All surface water discharges from Turkey Point activities are directed into the CCS, which does not directly connect to any other surface water bodies.

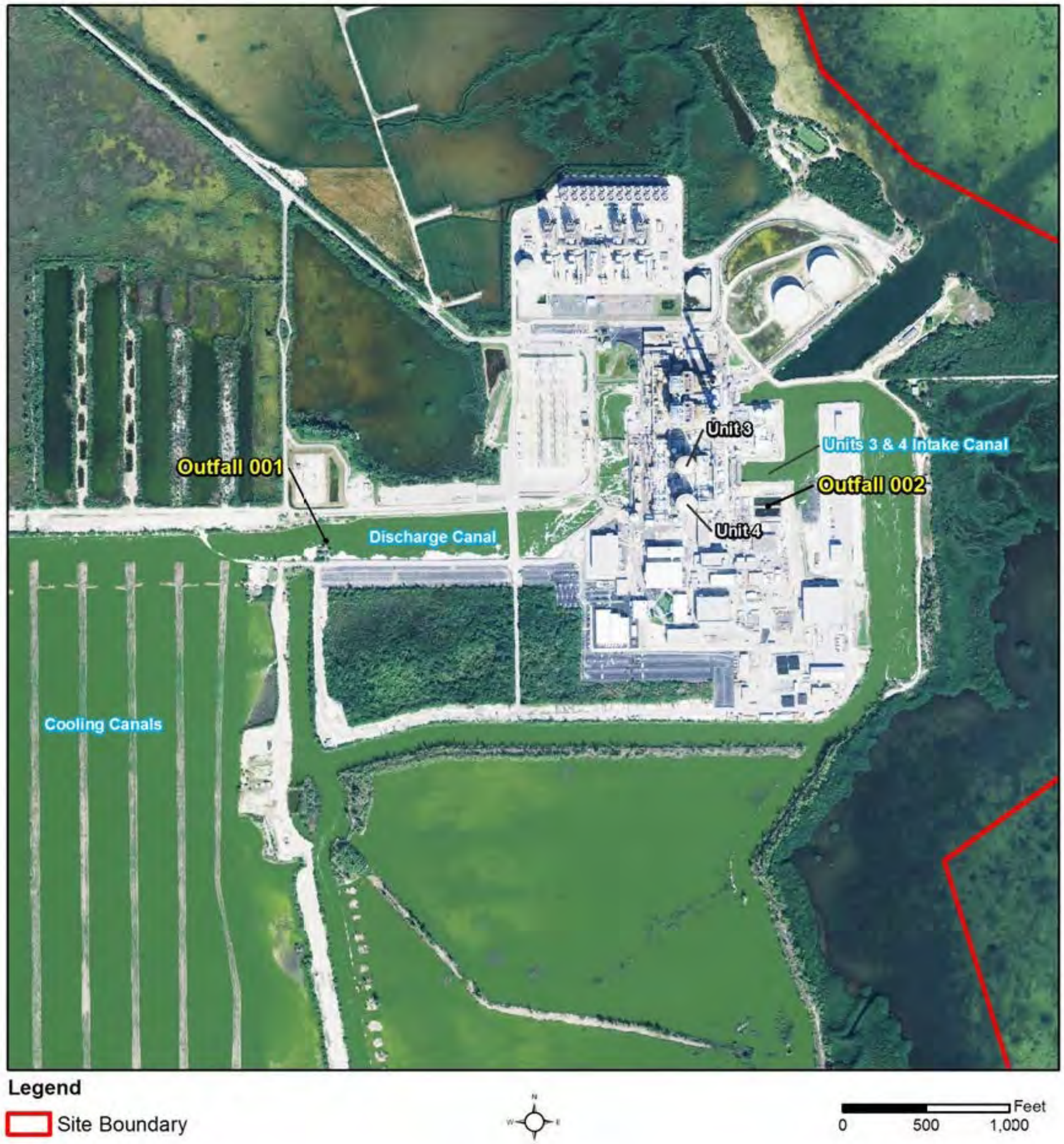
Sanitary wastewater from Turkey Point is routed to an onsite, county- and State-permitted, contact stabilization sewage treatment plant. Effluent from this wastewater treatment plant is discharged to an onsite, permitted, single Class V, Group 3 gravity underground injection well. The well is used to dispose of up to 35,000 gpd (132 m^3/day) of domestic wastewater effluent. It discharges into the top of the Biscayne aquifer and is open from 42 to 62 feet (12.8 to 19 m) below ground surface. Any wastewater residuals are transported to an approved offsite facility. FPL monitors the clarified wastewater sludge to ensure it does not present a risk to the environment or to public health (FPL 2018f). The FDEP manages sanitary waste under FDEP Sewage Treatment Facility Domestic Wastewater Facility Permit No. FLAO13612-002-DW3P and FDEP Sanitary Wastewater Disposal Well Domestic Wastewater Facility Permit No. 0127512-002-UO.

FPL discharges stormwater and all other discharges from Turkey Point Units 3 and 4 and the other facilities at the Turkey Point site to the CCS. Consistent with EPA and State determinations, neither FPL nor the State of Florida considers the CCS to be "waters of the United States" or "waters of the State" (FPL 2018f). FPL operates the CCS as an industrial wastewater (IWW) facility under National Pollutant Discharge Elimination System (NPDES)/IWW Permit No. FL0001562 (FDEP 2005). This permit is issued pursuant to the Federal NPDES program and the Florida Industrial Waste Water permitting program. FPL submitted a permit renewal application to the State of Florida on October 21, 2009. Since that time, the 2005 permit has been administratively continued and remains in effect at this time. The NPDES permit covers all plant discharges including discharges from Turkey Point Units 1, 2, 3, 4, and 5.

The NPDES permit (FDEP 2005) authorizes wastewater discharges, including stormwater, through two internal outfalls into the CCS. Internal Outfall I-001 is located on the southern bank of the discharge canal that leads to the CCS; Internal Outfall I-002 is located in the Units 1 and 2 settling basins (see Figure 3-13). Stormwater from Turkey Point discharges through Internal Outfall I 002 (FPL 2018f). Water quality parameters monitored by FPL under the Turkey Point NPDES permit include copper, iron, lead, pH, salinity, specific conductance, temperature, total suspended solids, zinc, and oil and grease (FPL 2018f).

The permit authorizes discharges to "waters of the State." However, while the permit authorizes discharges to "groundwater of the State" it does not authorize direct discharges to surface waters of the State. The permit authorizes discharges from the CCS into the surficial aquifer, which is the Biscayne aquifer. Beneath the CCS, the groundwater in the Biscayne aquifer is classified as Class G-III groundwater (FDEP 2005, FPL 2018f). As a result of its high total dissolved solids content, Class G-III groundwater is not considered to have a reasonable potential as a future source of drinking water (FPL 2018f, FAC 62-520.410, UF 2018a).

While the State of Florida regulates nonradioactive liquid releases from Turkey Point, the NRC regulates radioactive releases from Turkey Point. Liquid releases of radionuclides within NRC allowable limits are a part of normal nuclear power plant operations. Liquid releases from Turkey Point operations are discharged into the CCS via Internal Outfall I-001 (FPL 2018f). The NRC monitors the amount and types of radionuclides and the calculated dose to the public to confirm that releases are below NRC thresholds as defined in NRC regulations.



Source: From FPL 2018f

Figure 3-13 Florida Department of Environmental Protection NPDES Permitted Outfalls

As discussed above, the FDEP is conducting a renewal process for FPL's NPDES permit for the Turkey Point site. The draft NPDES permit (FDEP 2018f) was issued by FDEP in December 2018 for public review and comment. The draft NPDES permit would continue to authorize the CCS to discharge to Class G-III groundwater and would prohibit surface water discharges from the CCS through a point source to the surface waters of the State. The draft NPDES permit contains numerous monitoring and reporting requirements. Many of these requirements include monitoring activities currently being conducted by FPL in accordance with a Consent Order issued by the FDEP and a Consent Agreement with Miami-Dade County. It also contains requirements for impoundment design, construction, operation, and maintenance.

CWA Section 401 Certification

Section 401 of the Clean Water Act (33 U.S.C. 1251 et seq.) requires an applicant for a Federal license to conduct activities that may cause a discharge of regulated pollutants into navigable waters to provide the licensing agency with a water quality certification from the State. This Section 401 certification implies that discharges from the project or facility to be licensed will comply with Clean Water Act requirements and will not cause or contribute to a violation of State water quality standards. If the applicant has not received a Section 401 certification, the NRC cannot issue a license unless that State has waived the requirement. The NRC recognizes that some NPDES-delegated States explicitly integrate their Section 401 certification process with NPDES permit issuance (NRC 2013a).

The Power Plant Siting Act (PPSA) certification from the State of Florida is a non-expiring permit that remains valid for the life of the facility. Under the PPSA, FPL is not required to obtain a new certification for NRC subsequent license renewal. The certification will remain effective, as will any legal effects of the certification, including the certification's compliance with State water quality standards for the life of the facility. Therefore, there is no requirement for FPL to obtain a new determination of compliance with State water quality standard for Turkey Point Units 3 and 4 subsequent license renewal (FPL 2018f, FPL 2018g).

3.5.1.4 Adjacent Surface Water Quality and Cooling Canal System Operation

Within the Turkey Point site, the cooling canal system is the largest body of water. This section of the SEIS describes recent studies to evaluate potential effects of CCS operations via the movement of groundwater from the CCS to adjacent surface water bodies.

Pursuant to the State of Florida Department of Environmental Protection Conditions of Certification for Florida Power & Light Company Turkey Point Plant Units 3 and 4 Nuclear Power Plant Unit 5 Combined Cycle Plant Certification Number PA 03-45E (FDEP 2016b, State of Florida Siting Board 2016) and in accordance with the FPL Turkey Point Power Plant, Groundwater, Surface Water, and Ecological Monitoring Plan (SFWMD 2009), FPL conducts an extensive water quality monitoring program that includes the CCS, Biscayne Bay, Card Sound, marshland, mangrove areas, and canals adjacent to the CCS. A major objective of this program is to evaluate the effects, if any, of CCS operation on the surrounding environment. The monitoring program and some of its data and findings are contained in a number of documents that FPL submitted to the FDEP and partner agencies including the South Florida Water Management District (SFWMD) and Miami-Dade County (FPL 2010, FPL 2011a, FPL 2014b, FPL 2016a, FPL 2016f, FPL 2016g, FPL 2017a, FPL 2017b, FPL 2018p) (See Figure 3-14). Data and reports are also accessible through FPL's Electronic Data Management System (EDMS; https://www.ptn-combined-monitoring.com).

This water quality monitoring program monitors surface water bodies for numerous water quality parameters, including ammonia and other nutrients and salinity. Water temperature in the CCS is also monitored, but FPL has not detected CCS waters affecting temperatures in adjacent water bodies.

FDEP Administrative Order DEP #16-0111, uses tritium, in conjunction with saline water, as a tracer to estimate the spatial extent of waters originating from the CCS (FDEP 2016h). At levels in accordance with NRC allowable limits, Turkey Point Units 3 and 4 discharge liquid water containing tritium into the CCS in batch releases. Units 3 and 4 also release tritium as a gaseous emission (steam water or vapor water) into the air.

Tritium is a hydrogen atom with an atomic mass of three instead of one (NRC 2006a); like any other hydrogen atom, it usually binds with oxygen to form a water molecule. A water molecule that contains hydrogen in the form of tritium will behave in the environment just like a water molecule that does not contain tritium. There are two possible pathways for tritium to leave the CCS and move to another surface water body: (1) through the groundwater pathway within liquid water or (2) through air within gaseous water (steam or vapor water). Therefore, for surface water samples collected in bodies of water near the CCS, these two possible pathways are considered when interpreting the data.

Tritium emits a weak form of radiation in the form of a low-energy beta particle similar to an electron. This radiation does not travel very far in air and cannot penetrate the skin. If tritium enters the body, it disperses quickly and is uniformly distributed throughout the soft tissues. Tritium has a half-life of 12.3 years. This means that after 12.3 years, half of the tritium will be gone through decay into a form that is no longer radioactive. However, if ingested, the human body excretes half of the tritium ingested within approximately 10 days (NRC 2006a). For tritium in drinking water, EPA has established a maximum contaminant level of 20,000 pCi/L (EPA 2002, NRC 2006b).

At the levels that have been measured within the CCS, tritium is not a public health concern. With the exception of rare outliers, measurements of tritium concentrations at sampling locations within the CCS have been below the EPA maximum contaminant level of 20,000 pCi/L for tritium in drinking water. Although tritium levels in some areas may somewhat exceed the EPA's maximum contaminant level of 20,000 pCi/L for tritium in drinking water, salt concentrations make the water in the CCS non-potable, and there are no drinking water wells on or near the site. Also, while tritium has been detected in adjacent water bodies, the concentrations were very low and often extremely low relative to the EPA's maximum contaminant level of 20,000 pCi/L for tritium in drinking water (FPL 2010, FPL 2011a, FPL 2014b, FPL 2016a, FPL 2016f, FPL 2016g, FPL 2017a, and FPL 2017b).

Water Quality within the Cooling Canal System

The following text describes ammonia and nutrients and salinity conditions within the CCS. As CCS water temperatures also have an effect on CCS water salinities, the following text also includes a discussion of water temperature in the CCS. Any mitigating actions within the CCS to reduce any indirect effects on groundwater, ecology, and on adjacent surface water bodies are also described.

Ammonia and Nutrients within the Cooling Canal System

Ammonia is released into the waters of the CCS by the decay of organic material within the CCS. Between June 2010 and May 2016, ammonia concentrations within the CCS ranged from below detectable levels to 0.3 mg/L and averaged 0.04 mg/L (FPL 2017a). The Miami-Dade County water quality standard for ammonia is 0.5 mg/L (FPL 2018m). The Turkey Point CCS values are all below this standard.

Source: From FPL 2017a

Figure 3-14 Locations of Surface Water Monitoring Stations

Ammonia is a nutrient. Other nutrients include phosphorus, chlorophyll, and total nitrogen. Within a surface water body, if the concentration of nutrients gets too high, the nutrients can cause algae blooms. These algae blooms can be toxic, deplete oxygen in the water, and reduce water clarity (FDEP 2018e).

Nutrients are added to the water in the CCS by the erosion of soil and vegetation that falls into the canals from the land that separates the individual channels within the CCS. Nutrients are also added by groundwater inflows, atmospheric deposition (of nitrogen) and by the relatively low levels of effluents from power plant operations. Nutrients are removed from the CCS by the growth of seagrass, the harvest of seagrasses as a CCS maintenance activity, the removal of biological material impinged on the plant intake screens, and the outflow of water from the CCS into groundwater (FPL 2018f).

Prior to 2010, the CCS operated as a seagrass-based biological system. Seagrass grew beneath the water on the bottom of the channels, covering an estimated 50 percent of the channel bottoms. The seagrass provided habitat for aquatic life, provided natural filtration of suspended material, and removed nutrients from the water within the CCS. This ecosystem helped to maintain good water quality and low nutrient concentrations in the CCS waters (FPL 2018f).

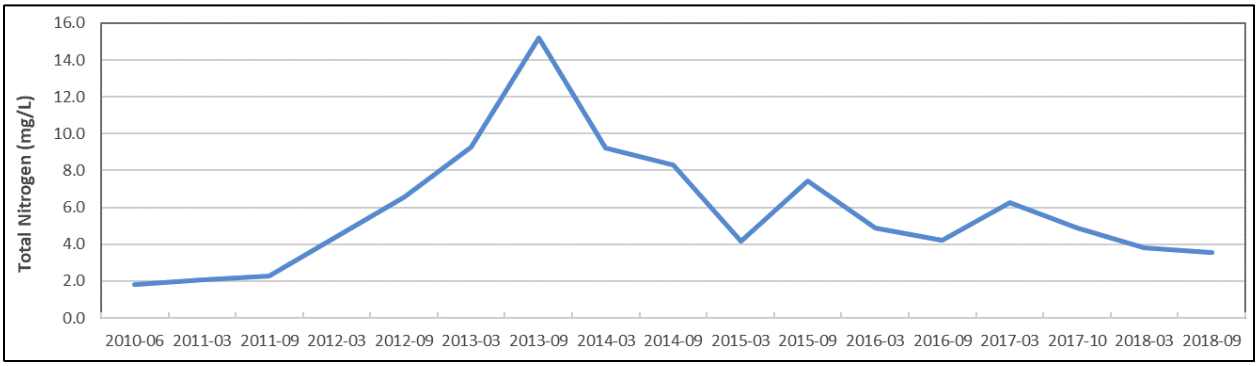
By 2010, this ecosystem had begun to change dramatically. CCS salinities had increased to the point that the seagrass meadows were dying. By 2012, few seagrass beds remained. The decomposition of the dead seagrass released a significant volume of nutrients into the waters of the CCS. This increase in nutrients facilitated seasonal algae blooms, resulting in high turbidity and generally degraded water quality within the CCS (FPL 2018f).

Nutrient Management Plan for the Cooling Canal System

In accordance with a June 20, 2016, Consent Order between FPL and the State of Florida (FDEP 2016a), FPL submitted to the FDEP a Nutrient Management Plan for the CCS (FPL 2016k). The plan is composed of three primary near-term nutrient management strategies: (1) active algae and nutrient removal, (2) canal and berm maintenance, and (3) salinity reduction and controlled flow management. On July 7, 2017, the FDEP directed FPL to implement the plan (FPL 2017b, FPL 2018p).

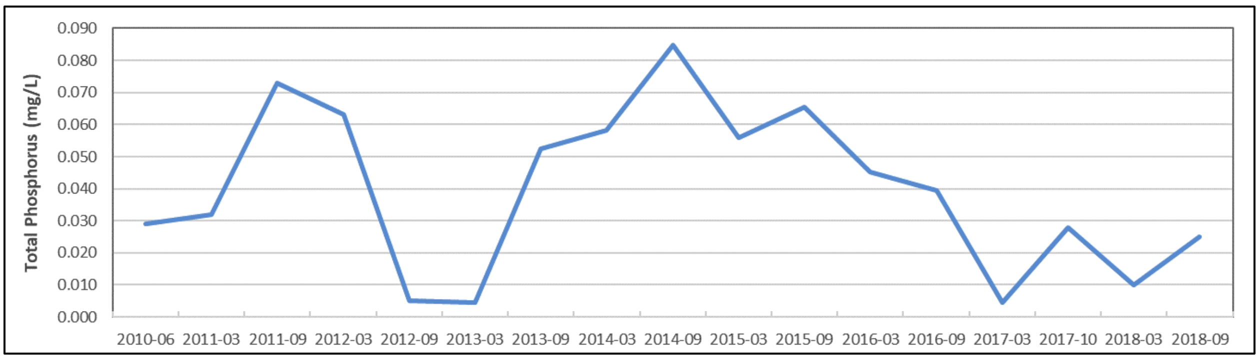
Under this Nutrient Management Plan, FPL (2016k) has performed bench and pilot tests to find the most appropriate active nutrient and algae removal methods for the unique ecology and water chemistry of the CCS. These nutrient and algae removal methods include using chemical flocculants/coagulants, nonchemical means (i.e., physical removal), and aeration. In addition, FPL reviewed and revised Turkey Point canal practices to integrate the goal of minimizing erosion and nutrient inputs from sediment and berm sources (FPL 2017b, FPL 2018p). FPL's reports (FPL 2018p) and available data show that nutrient management activities in the CCS, including canal sediment removal, canal berm management, vegetation management, freshening with low-nutrient groundwater, and groundwater extraction, have been effective in reducing nutrient concentrations. Specifically, total nitrogen and total phosphorous concentrations (semiannual) in the CCS exhibit substantial declines from peak concentrations as shown in Figures 3-15a and 3-15b, respectively.

Another component of the Nutrient Management Plan is the reestablishment of seagrass meadows within the CCS to provide stabilizing nutrient reduction and habitat for aquatic species. In the plan, FPL (2016k) identifies this objective to be a long-term activity. Section 3.7.3, "Aquatic Resources on the Turkey Point Site," of this SEIS describes FPL's efforts to achieve this objective.



Source: From FPL 2018p

Figure 3-15a Trend in Total Nitrogren Concentrations in the CCS



Source: From FPL 2018p

Figure 3-15b Trend in Total Phosphorus Concentrations in the CCS

Temperatures within the Cooling Canal System

The temperature of the CCS varies in response to factors such as heated water discharged by Units 3 and 4 into the CCS, air temperature, wind, precipitation, Biscayne aquifer groundwater flowing into and out of the CCS, and water that FPL adds to the CCS from wells to reduce salinity. To a lesser extent, discharges of water into the CCS from the interceptor ditch and the Turkey Point Unit 5 cooling tower blowdown can also impact the temperature of water within the CCS.

Historically, Turkey Points Units 1, 2, 3, and 4 all contributed heat to the CCS. Units 1 and 2 are now retired and no longer contribute heat to the CCS. Even under current operations (i.e., after the NRC approved the extended power uprates for Units 3 and 4 on June 15, 2012 (NRC 2012)), the heat that Units 3 and 4 discharge to the CCS is less than the amount of heat Turkey Point had discharged to the CCS when Units 1, 2, 3, and 4 were all in operation.

Due to the discharge of heat into the CCS, water temperatures in the CCS are higher than ambient air temperatures (FPL 2018f). Surface water temperatures within the CCS are warmer in the summer months and cooler in the winter months (FPL 2016a). Water temperatures within the CCS also vary based on location. As water moves from the discharge area, through the canals, and then towards the intake area, the water temperature drops (FPL 2016a). As expected, the highest water temperatures in the CCS are found where Units 3 and 4 discharge hot water into the CCS (Station TPSWCCS-1); the lowest water temperatures are found at the cooling water intake for Units 3 and 4. From June 2010 through May 2017, average monthly temperature values collected at all seven monitoring stations within the CCS ranged from 52.7 °F (11.5 °C) to 115 °F (46.3 °C), and produced an average monthly temperature of 88 °F (30.4 °C) (FPL 2017a).

The CCS serves as the ultimate heat sink to cool Units 3 and 4. On August 8, 2014, the NRC established an ultimate heat sink temperature limit for the cooling canals of 104 °F (40 °C) (FPL 2018f, NRC 2014d, 79 FR 44464, 80 FR 76324). To judge compliance with this limit, FPL measures water temperature from a sampling location in the return canal in front of the cooling water intake structure. Data from this sampling location represent the temperature of the water after it has been cooled by the CCS. From June 2010 through May 2017, temperature measurements at this sampling location (station TWSWCCS-6) have not exceeded the NRC's ultimate heat sink limit of 104 °F (40 °C) (FPL 2017a).

Prior to August 2014, the NRC had set the ultimate heat sink limit at the slightly lower temperature of 100 °F (37.8 °C). In early July 2014, the water temperature in the cooling canals began to approach the limit of 100 °F (37.8 °C). FPL then requested an increase in the temperature limit; in response, the NRC performed a safety and environmental analysis, and then established the current heat sink temperature limit of 104 °F (40 °C) (NRC 2014b).

FPL believes that the 2014 increase in average CCS temperatures was necessitated by:

- low average precipitation into the CCS from 2011 through 2014
- poor water circulation through the CCS due to blockages and sediment accumulation
- reduced heat exchange efficiency caused by factors such as higher salinity, turbidity, and algal concentrations that reduced evaporation rates (FPL 2018f)

Since 2014, FPL has worked to reduce algae concentrations, improve canal circulation, and increase the inflow of groundwater from the Biscayne aquifer into the CCS by sediment removal from CCS channels. For a short period of time, to help lower CCS temperatures, freshwater from Canal L-31E, brackish water from the Upper Floridan aquifer, and saltwater from the Biscayne aquifer was added to the CCS.

According to its environmental report for subsequent license renewal, FPL's current plans to lower CCS temperatures and manage CCS water quality do not include the use of freshwater from State canals (FPL 2018f). In the future, should FPL need to use freshwater from State canals, FPL would need to seek permission to do so from the State and county governments. FPL states that plans to reduce CCS temperatures and manage CCS water quality include adding brackish water from the Upper Floridan aquifer, reducing algae in the CCS, continuing to remove sediment within the CCS, and, only in extraordinary circumstances, pumping saltwater from the Biscayne aquifer into the CCS (FPL 2018f).

Thermal Efficiency Plan for the Cooling Canal System

In accordance with the June 20, 2016, Consent Order between FPL and the State of Florida, FPL submitted a thermal efficiency plan for the CCS to the FDEP (FDEP 2016a). FPL has identified the maintenance of high thermal efficiency within the CCS as necessary for controlling evaporation and salinity in the CCS. The plan identified primary and secondary performance metrics. FPL will use these metrics to guide its actions to maintain high thermal efficiencies (i.e., thermal efficiency at equal to or greater than 70 percent). On July 7, 2017, the FDEP instructed FPL to implement this thermal efficiency plan (FPL 2017b, FPL 2018p).

Since July 2017, FPL has implemented several near-term actions under this thermal efficiency plan, including (1) sediment removal in many of the CCS canals, (2) flow management within the CCS, (3) water stage management, and (4) vegetation management. As a result, thermal efficiency in the CCS during the 2017 reporting period met the objectives of the plan, which is to maintain high thermal efficiencies at equal to or greater than 70 percent. For the period between October 2016 through September 2017, FPL reported an annual CCS thermal efficiency of approximately 84 percent (FPL 2017b). For the period between October 2017 through September 2018, the thermal efficiency was 85 percent (FPL 2018p).

Salinity within the Cooling Canal System

Water in the CCS contains significant concentrations of salt. CCS water is saltier than seawater (i.e., it is hypersaline). The salinities of seawater are around 34–35 practical salinity units (PSU). For the most recent year in which data have been collected (from June 1, 2017, to May 31, 2018), the salinity of water in the CCS averaged 49.5 PSU, which is about 1.5 times the salinity of seawater (EB 2018, FPL 2018o).

Salinities in the CCS increase when water leaves the CCS via evaporation and decrease when less saline water enters the CCS. The highest salinities in the CCS are likely to occur during times of low precipitation and when evaporation rates are high. Conversely, the lowest salinities within the CCS are likely to occur during times of high precipitation and when evaporation rates are low (FPL 2012a). Salinity concentrations are usually at minimum values during the wet season, with the highest salinities at the end of the dry season (FPL 2018f).

Most of the salt in the CCS comes from the groundwater of the Biscayne aquifer, which is saltwater. As groundwater from the Biscayne aquifer moves into the CCS, the salt it contains also moves into the CCS and becomes concentrated as water is lost from the CCS because of evaporation. The Biscayne aquifer obtains its salt from Biscayne Bay, and is hydraulically connected to both the Biscayne Bay and the CCS (FPL 2018f, Tetra Tech 2014, FPL 2016a).

Salt is removed from the CCS when water containing salt moves from the CCS into the Biscayne aquifer. Water that moves from the CCS into the groundwater is likely to reflect the hypersaline conditions of the CCS. With its higher salt concentrations, this CCS water is denser than the groundwater of the Biscayne aquifer (FPL 2018f).

As previously stated, CCS salinity fluctuates throughout the year such that the CCS exhibits lower salinity concentrations in the wet season and higher salinity concentrations in the dry season. For instance, FPL (2018o) reports that from June 1, 2017 through May 31, 2018, CCS salinity ranged from a low of 40.11 PSU to a maximum of 67.35 PSU. Salinity concentrations have also decreased as FPL has implemented freshening activities. During the first full year of freshening (June 1, 2017, through May 31, 2018), the average CCS salinity was 49.5 PSU, which is 10.8 PSU lower than the previous year's (June 1, 2016, to May 31, 2017) average salinity of 60.3 PSU (FPL 2017a, FPL 2018od). FPL's freshening activities are described in detail below.

When FPL first constructed the cooling canals in the 1970s, the salinity of the CCS water and the surrounding Biscayne aquifer were about equal to the salinity in Biscayne Bay (approximately 34 PSU) (FPL 2018f). CCS salinities are usually at minimum values during the wet season, with the highest salinities at the end of the dry season. During dry years (periods of drought) the overall salinities at the end of the year were higher than the salinities at the end of the previous year. In this way, drought years produced a ratcheting effect that caused the next year to begin the seasonal cycle of salinity concentrations at higher salinities than the previous year. As a result, average salinities in the CCS gradually increased from approximately 34 PSU in the early 1970s to approximately 90 PSU in 2014 and 2015 (FPL 2017a, FPL 2017b, FPL 2018f). As discussed above, salinity levels have decreased since then; the most recent data show an average salinity level of 49.5 PSU for the period of June 1, 2017 through May 31, 2018.

As CCS salinities increased, the seagrasses in the CCS died off. As the seagrasses died off, not only could they no longer remove nutrients from the water, their decomposition also released considerable amounts of nutrients into the water. The increased nutrient concentrations facilitated the growth of seasonal algae blooms (FPL 2018f). As previously mentioned, from 2011 through 2014, in combination with low average precipitation and poor water circulation through the CCS, the algae blooms contributed to increased temperatures and salinities within the CCS (NRC 2016a).

To help reduce the water temperatures and improve the water quality within the CCS, on June 27, 2014, the FDEP (2014) granted FPL permission to add Unit 5's excess allocation of Floridan aquifer water under an Administrative Order to the CCS. The FDEP (2016a) subsequently issued a Consent Order that superseded all requirements of its 2014 Administrative Order. In August 28, 2014, the SFWMD granted FPL permission to add freshwater from the L-31E Canal to the CCS to reduce salinity. After these additions, rainfall also added freshwater to the CCS. CCS salinities subsequently returned to pre-summer 2014 levels of around 60 PSU) (FPL 2018f; NRC 2016a). The status of actions to reduce salinities within the CCS since 2014 is described in the following section titled "Application of Numerical Modeling to CCS Salinity Mitigation." At the end of May 2017, salinity concentrations in the CCS were 64.9 PSU (FPL 2017b). As previously stated, during the most recent reporting period (from June 1, 2017 through May 31, 2018), the average salinity level in the CCS was 49.5 PSU.

Salinity Management Plan

In December 2014, the FDEP issued an Administrative Order requiring FPL to submit a salinity management plan to describe how FPL would reduce and maintain the average annual salinity in the CCS at or below 34 PSU (FDEP 2014, NRC 2016a). On October 7, 2015, Miami-Dade County and FPL signed a Consent Agreement (MDC 2015a). In this agreement, it was acknowledged that FPL would supply brackish water to the CCS from the Upper Floridan aquifer and saltwater from the Biscayne aquifer via marine wells (wells located adjacent to Biscayne Bay). However, FPL would work to avoid the use of water from the marine wells, except under extraordinary circumstances. Secondly, it was acknowledged that FPL would continue to use water from the L-31E canal to lower CCS salinities until a transition was made to long-term sources of water for the CCS (i.e., brackish water from the Upper Floridan aquifer) (MDC 2015a).

On June 20, 2016, a Consent Order (FDEP 2016a) was executed by FPL and the FDEP. The Consent Order requires FPL to maintain the average annual salinity of the CCS at or below 34 PSU. Further, it states that, "[i]f FPL fails to reach an annual average salinity of at or below 34 PSU by the end of the fourth year of freshening activities, within 30 days of failing to reach the required threshold, FPL shall submit a plan to the [FDEP] detailing additional measures, and a timeframe, that FPL will implement to achieve the threshold. Subsequent to attaining the threshold in the manner set forth above, if FPL fails more than once in a 3 year period to maintain an average annual salinity of at or below 34 PSU, FPL shall submit, within 60 days of reporting the average annual salinity, a plan containing additional measures that FPL shall implement to achieve the threshold salinity level" (FDEP 2016a).

This means that FPL has a requirement to reach the 34 PSU annual average salinity threshold in the CCS significantly before the beginning of the subsequent license renewal period. If the average annual salinity fails to reach that threshold in the fourth year of freshening activities, FPL may be required by FDEP to take additional freshening activities. While it cannot be guaranteed that the FPL will achieve the 34 PSU threshold within the 4-year timeframe; continued actions by FPL and regulatory oversight by the FDEP provide additional assurance that the CCS should reach the required PSU levels within the 13-year period prior to the beginning of the subsequent license renewal period.

In future years, it is anticipated that Upper Floridan aquifer wells will be the water source utilized for salinity reduction (FPL 2018f). As detailed in Section 3.5.2.2.3, FPL began operation of the Upper Floridan aquifer freshening well system on November 28, 2016. The addition of this brackish water (2.5 PSU) to the CCS is being used to help reduce the CCS salinity to an average annual level of 34 PSU. The addition of this water has been important in minimizing increases in CCS salinity that ordinarily occur during the dry season. Continued operation of the freshening wells during the wet season should further help to reduce CCS salinities (FPL 2018f, FPL 2018p).

Study of Water Alternatives to Reduce CCS Salinities

In the October 7, 2015, Consent Agreement between Miami-Dade County and FPL, it was acknowledged that FPL would consider the practicality and appropriateness of using reclaimed wastewater from the Miami-Dade County South District Waste Water Treatment Plant as an alternative water resource to reduce CCS salinities. To respond to this request, FPL contracted with Golder and Associates to evaluate alternative sources of water. Along with other alternatives, the evaluation considered the practicality and appropriateness of using reclaimed wastewater from the Miami-Dade County South District Waste Water Treatment Plant (SDWWTP) (Golder 2016).

The study considered the following eight alternatives:

1) Excess surface water from the L-31E Canal
2) Biscayne aquifer water from the Inland Biscayne Aquifer Wellfield
3) Reclaimed water from SDWWTP with nutrient removal
4) Reclaimed water from SDWWTP with nutrient removal and advanced treatment for other constituents of concern
5) Upper Floridan aquifer water using artesian wells flowing into the CCS
6) Direct Treatment of CCS water to remove salinity
7) Marine groundwater from wells on the Turkey Point Peninsula with additional fresh water from another source
8) Marine surface water from Biscayne Bay or Card Sound with additional fresh water from another source

The study considered technical, environmental, economic, and social criteria. Relative to the ranking criteria, it ranked Alternative Five as the best overall and the most balanced alternative. It also identified that Alternatives One and Seven should be maintained as short-term backup water options to be used when appropriate and as needed during extreme conditions. It further determined that Alternatives Two, Four, Six, and Eight did not provide a significant advantage and should not be evaluated further unless conditions change. While the study determined that Alternative Three has a high cost and very long implementation schedules; it concluded that this alternative should be further evaluated as a potential long-term solution to a regional problem (Golder 2016).

The alternatives study was reviewed by Miami-Dade County. On December 22, 2016, the County decided that the use of reclaimed water with nutrient removal and advanced treatment, described as (Alternative 4) in the referenced document, could provide a long-term, sustainable source of water to offset CCS water deficits. The County recommended that FPL revisit this alternative for further evaluation as a potential long-term solution (MDC 2016a). At the time of this report, FPL (2019e) and MDC were evaluating a potential cooperative reclaimed water use project to provide freshening water to the CCS.

Application of Numerical Modeling to CCS Salinity Mitigation

The operation of the CCS has been numerically modeled to understand and predict different aspects of the CCS (Chin 2016; Golder 2008; Tetra Tech 2014a; FPL 2012a, FPL 2014b, FPL 2016a, FPL 2016g, FPL 2017a). The most recent modeling was conducted by Tetra Tech for FPL. The focus of this modeling was to quantify the volumes of water and the mass of salt entering and exiting the CCS (FPL 2012a). Model calculations for the various components of the CCS incorporate hydrological, chemical, and meteorological data collected in and around the CCS (FPL 2012a). Selected model inputs were adjusted to calibrate the model against observed changes in CCS water and salt storage. The calibration minimized differences between simulated and observed salt and water storage changes within the CCS (FPL 2014).

The NRC staff and its contractors reviewed the underlying assumptions that formed the basis of the Tetra Tech CCS model and did not identify any significant issues. The staff's reviewers found that the model is useful in understanding the physics of the CCS and how it responds to changing conditions. It is also useful as a planning tool to refine future mitigative actions.

A good match between measured and model values gives modelers confidence that they understand how the CCS responds to meteorological conditions and freshening activities. The Tetra Tech model outputs are in good agreement with respect to measured values of CCS salinities, temperatures, water elevations, and the movement of salt and water movement into and out of the CCS (FPL 2017a). Both data measurements and modeling indicate that favorable meteorological conditions and freshening activities reduce salinities within the CCS (FPL 2017a, FPL 2017b, FPL 2018o).

The Tetra Tech model is being used by FPL to understand the effectiveness of its mitigation measures. The most recently published modeling results simulate the operation of the CCS from June 2015 through May 2017. The modelers concluded that over this time period, the addition of Upper Floridan aquifer water helped to moderate dry season salinity without significantly increasing water levels in the CCS (FPL 2017a).

In 2014, Tetra Tech used numerical models to estimate the volume of Upper Floridan aquifer water that would be required to reduce CCS water salinity to seawater range. The modeling exercise produced an estimate that with the addition of 14 mgd (53,000 m^3/day) of Upper Floridan aquifer water that had a salinity of 2 PSU it would require less than a year to reduce salinities in the CCS to 35 PSU (Tetra Tech 2014a). However, while FPL then added an average of 12.8 mgd (48,500 m^3/day) of Upper Floridan aquifer brackish water to the CCS for freshening purposes from the beginning of November 2016 to the end of May 2017, salinities in the CCS did not go down to 35 PSU (FPL 2017a). Rather, at the end of May 2017, salinity concentrations in the CCS were 64.9 PSU (FPL 2017b). As discussed above, CCS salinity levels deceased from that level in 2018.

Comparing CCS data and model results, the modelers concluded that during this period (most of which occurred during the dry season), evaporation rates exceeded precipitation rates. Without the addition of brackish water from the Upper Floridan aquifer, the net evaporation versus precipitation rate would have caused the salinity in the CCS to increase more than was observed. However, the addition of Upper Floridan aquifer water helped to moderate the effects of the dry season (typically, November - April) on the CCS. For example, CCS salinities during the dry seasons of 2014 and 2015, which were not as dry as 2017, exceeded 90 PSU, while the addition of brackish water from the Upper Floridan aquifer and saltwater from the marine wells was effective in keeping CCS salinities below 70 PSU in the 2017 dry season. The modelers anticipate that under more average meteorological conditions (e.g., less severe dry seasons), the addition of Upper Floridan aquifer water should help to reduce CCS water salinities to 34 PSU (FPL 2017a, FPL 2017b, FPL 2018o).

The Turkey Point site experienced a severe dry season in late 2017 (particularly into the first quarter of 2018) that resulted in the second driest period over the last 50 years. CCS salinities increased over this period. This was mitigated in part by rainfall from Hurricane Irma in September, which produced estimated rainfall totals averaging 4.96 in. (12.6 cm) over the CCS. However, dry conditions returned after the hurricane (FPL 2018o). These events exemplify the high variability of hydrologic inputs to the CCS. Nonetheless, with continued freshening from Upper Floridan aquifer water during the period from June 2017 through May 2018, the average annual salinity of the CCS declined to 49.5 PSU (or 50.9 PSU average annual salinity as calculated pursuant to the FDEP Consent Order, see next paragraph) (FPL 2018p).

The FDEP Consent Order prescribes how a numerical average called the “average annual CCS salinity” is to be calculated to determine compliance. As previously mentioned, using the method that has historically been used to calculate average CCS salinities, the average salinity in the CCS between June 1, 2017 to May 31, 2018, was 49.5 PSU. However, using the prescribed approach, the average annual salinity for this time period was 50.9 PSU. This was the first full year that the CCS was freshened using water from the authorized Upper Floridan aquifer wells. The 50.9 PSU value is lower than the preceding year's (June 1, 2016 to May 31, 2017) average annual salinity of 61.9 PSU, during which Upper Floridan aquifer freshening wells were operational for only half of the year. Considering that the highest CCS yearly salinity was 82.5 PSU (June 2014 through May 2015), it appears that a substantial reduction in CCS salinity has occurred over the past several years, in part as a result of FPL's actions (FPL 2018p).

As previously stated, in compliance with the June 20, 2016, Consent Order executed by FPL and the FDEP, if FPL fails to reach an annual average salinity of at or below 34 PSU by the required time periods, FPL is required to submit a plan to the FDEP detailing additional measures, and a timeframe, that FPL will implement to achieve the threshold (see Salinity

Management Plan) (FDEP 2016a). Thus, continued actions by FPL and regulatory oversight by the FDEP provide assurance that the CCS should reach the required PSU levels within or close to the designated period.

Ammonia and Nutrients within Biscayne Bay and Card Sound

If the concentration of nutrients in either Biscayne Bay or Card Sound get too high, they can negatively impact the ecological environment. Excess nutrients can cause algae blooms (thick green algae mats that can be toxic), deplete oxygen in the water, and reduce water clarity. The State of Florida (with the approval of the EPA) has established numeric nutrient criteria for Biscayne Bay and Card Sound. These water quality standards help to protect the quality of the surface water in the bay and the sound, consistent with the requirements of the Clean Water Act (EPA 2014c). The numeric nutrient criteria include criteria for phosphorus, chlorophyll, and total nitrogen, of which ammonia is a contributor (FDEP 2018e).

Biscayne Bay waters are generally low in plant nutrients. This means the aquatic ecosystems respond very rapidly to small nutrient enrichment, especially to increases of phosphorous. The concentrations of ammonia from runoff tends to be higher in urban runoff than in wetland or agricultural runoff. The Biscayne Bay watershed has a diverse agricultural, urban, and wetland land use. This results in lateral differences in bay water nutrient concentrations (NPS 2011).

In general, ammonia concentrations are higher in the northern portion of Biscayne Bay, which is most urbanized, while the lowest values are next to the Turkey Point site in Biscayne Bay and in Card Sound. The lack of urban development around the Turkey Point site has helped spare the southern portion of the bay from the anthropogenic effects to which the central and northern portions of the bay have been exposed (FPL 2017c; NPL 2011).

Seasonal ammonia values in the bay are lowest late in the dry season, with higher concentrations and increased variability during the wet season (peaking in September or October) (NPS 2011). Sampling data by Miami-Dade County and FPL in the late fall and winter months of 2015–2016, revealed levels of ammonia concentrations that exceeded the County's water quality standard for ammonia (0.5 mg/L) at two surface water quality monitoring stations near the CCS in bottom samples collected from two deep non-CCS canals (MDC 2016a). The exceedances for ammonia were detected in the Barge Turning Basin and the remnant canal at Turtle Point (TPBBSW-7 and TPBBSW-8).

Both the Barge Turning Basin and the remnant canal at Turtle Point are connected to Biscayne Bay. When it was constructed, the Barge Turning Basin was excavated to a depth of approximately 30 ft (9.1 m) and the Turtle Point remnant canal was excavated to a depth of approximately 20 ft (6.1 m). In Biscayne Bay, nearby areas have a depth to the bottom of about 1 to 2 ft (0.3 to 0.6 m) (FPL 2018g) (Figure 3-4).

The ammonia exceedances were detected in samples obtained from the bottom of these excavations, close to the CCS. The low dissolved oxygen, hypersalinity, and tritium concentrations found at these locations are consistent with the interpretation that, close to the CCS, the water quality at the bottom of these excavations may be influenced by groundwater that has been in contact with CCS waters. However, the ammonia concentrations in the bottom samples were consistently higher than ammonia levels in the CCS (FPL 2016g). This implies that if groundwater from the CCS was moving into these excavations, some of the ammonia in the Turtle Point remnant canal and the Barge Turning Basin was also coming from other sources.

On April 25, 2016, FDEP issued a Warning Letter to FPL concerning sampling events that indicated that groundwater originating from beneath the CCS is reaching tidal surface waters connected to Biscayne Bay in artificial deep channels immediately adjacent to the CCS. The Warning Letter requested that FPL provide facts to assist in determining whether any violations of Florida law have occurred (FDEP 2016i).

On May 16, 2016, FPL submitted to the FDEP the nutrient monitoring results from certain surface water monitoring stations in deep channels adjacent to the CCS (FDEP 2016a). The FDEP reviewed this information and determined that no exceedances of surface water quality standards were detected in Biscayne Bay monitoring. However, to minimize the potential for future exceedances, the FDEP ordered FPL to implement restoration projects at the Barge Turning Basin and within the remnant canal at Turtle Point (FDEP 2016a).

Restoration activities at the Barge Turning Basin include backfilling the Barge Turning Basin up to a depth of 15 ft (4.6 m) below MSL. Restoration activities at the Turtle Point Canal included backfilling one-third of the remnant canal up to a depth of 0.33 ft (0.1 m) below MSL and the planting of approximately 1,700 mangrove trees (FPL 2019e). The rest of the remnant canal will be backfilled with a sloping fill to a final depth of 7 ft (2.1 m) below MSL (FPL 2017c). Planting the backfilled shallow portion with mangrove trees will reduce the accumulation of organic matter in these deep areas and reduce or eliminate the movement of groundwater from the CCS into these deep excavations connected to Biscayne Bay (FPL 2018d, FPL 2018g). The Turtle Point Canal restoration was completed in April 2019; restoration of the Barge Turning Basin began in May 2019, and was completed in September 2019 (FPL 2019e).

The ammonia exceedances in the Barge Turning Basin and in the Turtle Point Canal also led to the modification of a consent agreement between the County and FPL in 2016. The modified consent agreement requires FPL to prepare and implement a corrective action plan to address ammonia exceedances in surface water surrounding the facility including, but not limited to, waters tidally connected to Biscayne Bay (MDC 2016b, FPL 2016h).

In response to the modified consent agreement between FPL and Miami-Dade County, FPL submitted a site assessment plan to Miami-Dade County on September 14, 2016 (FPL 2016g). The plan described a program to identify the source of the ammonia and to define its vertical and horizontal extent within nearby surface waters. Under the plan, an extensive sampling and analysis program was then conducted by FPL that included numerous surface water, porewater, canal, and groundwater sampling locations, as well as stratified surface water sampling and temporal sampling based on tidal cycles. The assessment results were evaluated in detail to determine the nature and extent of ammonia at Card Sound, Turkey Point, the Barge Turning Basin, and in remnant dead-end canals. In addition, an evaluation of water quality within the CCS was performed (FPL 2016h, FPL 2017c).

The study and its conclusions are contained in a site assessment report published on March 17, 2017 (FPL 2017c). The report concluded that the elevated ammonia values are attributable to the degradation of plant and animal material under anoxic (low oxygen) conditions in areas with little or no mixing with other surface waters. The occurrence of ammonia appears to be limited to the locations of deep stagnant anoxic water bodies. Some of the deep canal sites and many of the groundwater and porewater sites were anoxic and the majority of nitrogen was in the form of ammonia. The studied areas are similar to many locations in coastal Southeast Florida. Regional studies of background surface water quality data for Biscayne Bay indicate that ammonia can be detected at many locations that are not associated with the CCS, at levels greater than 0.5 mg/L (FPL 2017c).

The 2017 report further concluded that the elevated ammonia values were not the result of contamination attributable solely to the Turkey Point site but were the result of natural microbial processes in anoxic, stagnant surface and groundwater environments (FPL 2017c). Ammonia concentrations in the CCS were found to be very low, and the report therefore concluded that the CCS was not the direct cause of the elevated ammonia concentrations in the Turtle Point remnant canal and the Barge Turning Basin. Only surface water samples collected from the bottom of the dead-end canals exceeded the Miami-Dade County standard for ammonia. Outside of these areas, no exceedance of the standard was detected in any other samples within Biscayne Bay near the CCS or in the CCS (FPL 2017c).

The 2017 report also concluded that the ammonia values are consistent with the anoxic conditions that exist at the bottom of remnant canals and the accumulation of organic matter falling into the remnant canals from surrounding areas of the bay. Based on the information obtained, additional work and a corrective action plan were not recommended (FPL 2017c).

Staff from Miami-Dade County reviewed the 2017 report on ammonia in surface waters and on July 7, 2017, requested that FPL submit more information (MDC 2017d). On July 10, 2018, the Miami-Dade County Division of Environmental Resources Management (DERM) issued a letter finding that total ammonia concentrations at the Barge Basin and the Turtle Point remnant canal exceeded the applicable Miami-Dade County surface water standard (MDC 2018a). The DERM acknowledged that the observed elevated surface water ammonia concentrations may be attributable to several contributing sources, including factors not directly related to the operation of the CCS; however, based on an evaluation of tritium concentrations and temperature data, DERM found that the CCS is a contributing source to the ammonia concentrations in those areas.

The DERM letter required FPL to submit a plan to address CCS nutrient impacts to groundwater and surface water resources beyond the boundaries of the CCS. In the letter, DERM acknowledged that management of water quality within the CCS may be effective in reducing water quality impacts observed beyond the CCS facility boundaries. DERM also required FPL to implement the proposed plan to fill the Barge Basin and the Turtle Point remnant canal (MDC 2018a).

In an October 2018, response to a July 10, 2018, DERM letter (FPL 2018r), FPL stated that ammonia concentrations in drainage canals adjacent to the CCS were found in bottom samples where dissolved oxygen levels were less than 1.0 mg/L and in the vertical middle portions of the water column within Turtle Point Canal, where the dissolved oxygen levels were also less than 1.0 mg/L. The letter also contains a detailed explanation of the FPL strategy to address CCS nutrients. This strategy consists of three elements: (1) continued implementation of CCS canal practices, (2) external canal practices, and (3) monitoring and reporting.

Individual measurements of nutrients within an open body of water can be highly variable, both spatially and temporally, making it difficult to accurately characterize prevailing conditions. However, over time, nutrients present in the water column become sequestered in the water in the bottom sediments used by seagrasses for growth. Therefore, nutrient concentrations in leaf tissue can provide a more reliable gauge of prevailing nutrient loads and limiting nutrients within the ecosystem.

The FPL monitoring program that evaluates the effects, if any, of CCS operation on the surrounding environment, has incorporated this technique in its ecologic transects in Biscayne Bay and Card Sound. This technique has been used at Turkey Point since at least 2010, and it measures total nitrogen, total phosphorous, and total carbon values. The data collected by this technique were also evaluated for nutrient ratios. Analysis of nutrient ratios provide an indication of which elements limit seagrass growth. The nutrient ratios indicate that phosphorous is the limiting nutrient to seagrass growth. This finding is comparable to similar areas in Biscayne Bay and Florida Bay.

In general, leaf nutrient values were found to be within the range of values reported for similar areas of South Florida. Although there is considerable temporal and spatial variability in levels of leaf nutrients within the project area, the patterns observed among study areas provide no indication of any CCS influence on the seagrass community but, rather, reflect regional landscape hydrology and anthropogenic management influences (FPL 2018o, FPL 2017a, FPL 2016b, FPL 2016a, FPL 2014b, FPL 2012a).

Section 3.5.2.2, “Groundwater Quality” (“Groundwater Quality and Changes Attributable to Turkey Point Operations”) of this SEIS describes the results of FPL’s monitoring of nutrients in groundwater in and around the CCS. Section 3.7.4, “Biscayne Bay and Card Sound Semiannual Monitoring,” of this SEIS describes in more detail FPL’s ongoing efforts to monitor submerged aquatic vegetation monitoring and seagrass leaf nutrient content.

<u>Salinity within Biscayne Bay and Card Sound</u>

The salinity of the water in Biscayne Bay and Card Sound affects their ecosystems. Sustained lower-than-seawater salinities are required to maintain the ecology of freshwater wetland, tidal wetlands and mainland nearshore areas, to provide nursery habitat for fish and shellfish (Audubon 2016, NPS 2012). As previously mentioned, the salinities in Biscayne Bay adjacent to the Turkey Point site and Card Sound are most affected by the amount of precipitation that falls in and around the bay and the sound. Also, depending on the hydraulic head in the underlying Biscayne aquifer relative to the head (water levels) in Biscayne Bay, water in the Biscayne Bay (and therefore salt), either moves from Biscayne Bay into the underlying aquifer or from the underlying aquifer into Biscayne Bay.

Within Biscayne Bay and Card Sound, near-shore areas next to the mainland have a larger range of salinity values than mid-bay or mid-sound locations. This is because near-shore areas are more affected by freshwater inflows and evaporation than mid-bay and mid-sound locations (NRC 2016a).

The surface water monitoring program, which, in addition to surface water samples, includes porewater samples and shallow monitor well samples in the Bay, has not detected a discernable effect from the CCS on the salinity of Biscayne Bay or Card Sound (FPL 2016a, FPL 2018f).

<u>Ammonia and Nutrients and Salinity within Marsh Land and Mangrove Areas</u>

The monitoring program has not detected evidence in the surrounding marsh and mangroves areas of any impacts of ammonia, nutrients, or salinity from the CCS on soil porewater quality via the groundwater pathway (FPL 2014b, 2016a, 2017a, 2018f, 2018o).

<u>Ammonia and Nutrients and Salinity within Adjacent Canals</u>

On the west side of the CCS, the interceptor ditch (which is about 18 ft (5.5 m) deep), serves to keep groundwater under the CCS from moving west. However, there is no interceptor ditch along the southern boundary of the CCS (Figure 3-4). Within the CCS, the canal that runs along the southern boundary is 20 ft (6.1 m) deep. The S-20 canal and the Card Sound remnant canal lie adjacent to the CCS with no intervening interceptor ditch. At these locations, the S-20 Canal is 5 ft (1.5 m) deep and the Card Sound remnant canal is more than 20 ft (6.1 m) deep (FPL 2014b). Therefore, due to their close proximity to the CCS, these are locations where CCS water may more readily move into an adjacent canal via the groundwater pathway.

During the 2018 annual monitoring period from June 1, 2017, through May 31, 2018, water in the L-31E canal exhibited significant increases in salinity. Ammonia concentrations in the section of the L-31E canal north of the partial plug also exhibited significant increases. The salinity increases occurred during and after an extended dry period; ammonia increases were also detected after Hurricane Irma in fall 2017. Increases in salinity were observed in most of the marsh sites in response to dry conditions during the drought and in response to the storm surge during Hurricane Irma. Increases in soil porewater salinities were also detected at all ecological transects, including one located approximately 4 mi (6.5 km) southwest of the CCS (FPL 2018o). The NRC staff reviewed data in FPL's Electronic Data Management System (EDMS; https://www.ptn-combined-monitoring.com) and agrees with the conclusion expressed in FPL (2018o) that the increases in salinity and ammonia are not believed to have been caused by a failure of the interceptor ditch or by the CCS.

During the annual monitoring period from June 1, 2017, through May 31, 2018, some ecologic transects exhibited vegetation impacts from droughts and storms. North of the CCS, all the sawgrass in plot F1-1 died after Hurricane Irma because of high porewater salinity. This likely resulted from the accompanying storm surge. In May 2018, some regrowth at this site was observed. Two mangrove-reference transect plots located approximately 5 mi (8 km) southwest of the CCS (M6-1 and M6-2) experienced a decrease in biomass and height. Hurricane Irma may have impacted these mangrove sites, because they did not have a protective fringe mangrove forest (FPL 2018o). Section 3.6.2, "Marsh, Mangrove, and Tree Island Semiannual Monitoring," of this SEIS describes the results of FPL's ecological monitoring in more detail.

With the following exceptions, no readily apparent impacts of ammonia, other nutrients, and salinity on surface water quality in canals adjacent to the Turkey Point site, from the CCS via the groundwater pathway, have been detected (FPL 2016a, FPL 2018o). During the June 2014 to May 2015 monitoring period, monitoring detected an intermittent influence from the CCS at two monitoring locations in canals immediately adjacent to the CCS. One station is located in the S-20 canal and one station is located in the Card Sound remnant canal. The identification of CCS influence was determined based on small temperature variations and higher tritium and salinity values than would normally be expected. However, no readily discernible influence from the CCS was detected at these locations during the June 2013 to May 2014 monitoring period or the June 2016 to May 2017 monitoring period (FPL 2012a, FPL 2014b, FPL 2017a). Minimal, if any, influence on surface water quality was detected where the canals connect to Card Sound (FPL 2016a).

On July 10, 2018, the Miami-Dade County DERM issued a letter stating that total ammonia concentrations at some sampling locations in the Card Sound remnant canal, the S-20 canal, and in the Sea-Dade remnant canal, exceeded the applicable Miami-Dade County surface water standard (i.e., 0.5 mg/L). This letter acknowledged that the elevated surface water ammonia concentrations may be attributable to several contributing sources, including factors not directly related to the operation of the CCS. However, based on an evaluation of tritium concentrations and temperature data, the DERM found that the CCS is a contributing source to the ammonia concentrations in these areas (MDC 2018a). The DERM also acknowledged that the management of water quality within the CCS may be effective in reducing water quality impacts beyond the CCS boundaries, and it required FPL to submit a plan to address CCS nutrient impacts to groundwater and surface water resources beyond the boundaries of the CCS (MDC 2018a). On October 8, 2018, FPL responded to the July 10, 2018, letter and submitted a plan to address CCS nutrient impacts.

3.5.2 Groundwater Resources

Groundwater includes all water below the ground surface, usually within a zone of saturation. Aquifers contain groundwater in sufficient volume to supply wells, springs, and surface water.

3.5.2.1 Hydrogeology and Aquifers

The NRC staff's EIS for the Turkey Point, Units 6 and 7 combined licenses (NUREG–2176) contains an extensive description and evaluation of the hydrogeologic system of the southern Miami-Dade County region, focusing on the Turkey Point site (NRC 2016a). The summaries of site hydrogeology in this section of the SEIS are primarily based on NUREG–2176, as well as on FPL's environmental report submitted as part of the Turkey Point subsequent license renewal application (FPL 2018f). Where appropriate, the NRC staff has summarized referenced information or incorporated information by reference into this SEIS so that the following subsections can focus on new and potentially significant information since initial license renewal of Turkey Point Units 3 and 4 in 2002. The discussions and analyses that follow focus on aspects of the aquifer systems and the interactions with ongoing Turkey Point operations including the CCS, also called the industrial wastewater (IWW) facility. For a detailed description of the CCS, see Section 3.1.3, "Cooling and Auxiliary Water Systems," of this SEIS.

Two major aquifer systems underlie the region and the Turkey Point site: (1) the surficial aquifer system consisting of the Biscayne aquifer, and (2) the deeper Floridan aquifer system (FPL 2018f, NRC 2016a). Figure 3-7 in Section 3.4 of this SEIS shows the orientation, depths, and thicknesses of the aquifers beneath the Turkey Point site, including the named stratigraphic units and the lithologies (rock types) comprising them.

During the NRC staff's June 2018 environmental site audit (NRC 2018c), the staff toured the facilities and locations discussed below, including the CCS and related structures, Upper Floridan aquifer production (i.e., CCS freshening) well locations, hypersaline recovery wells and the associated deep injection well, and the Turtle Point and Barge Basin restoration project sites.

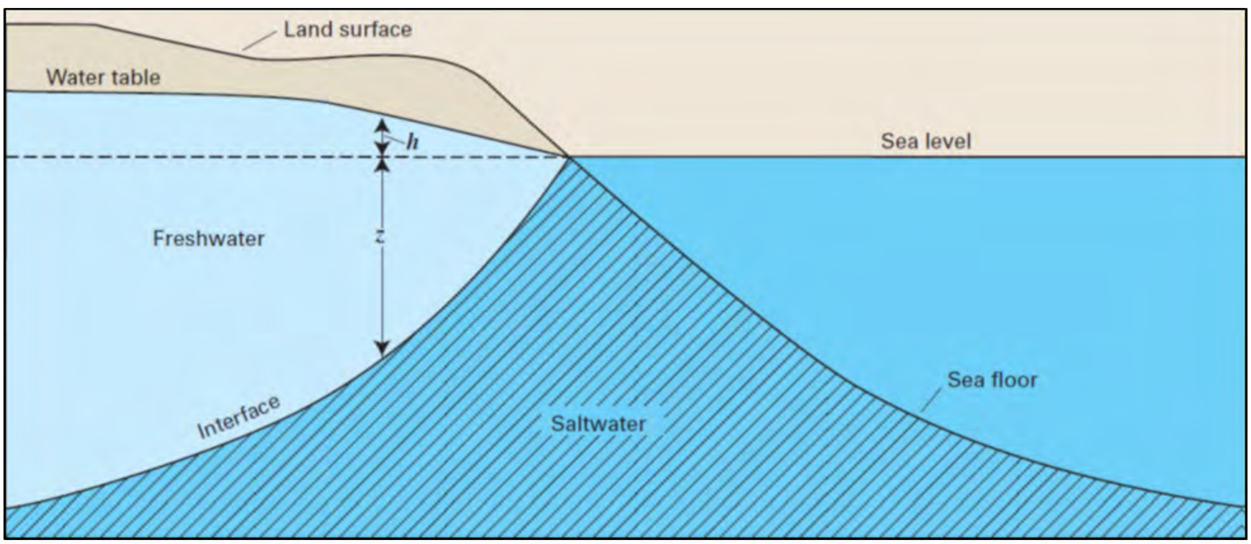
<u>Biscayne Aquifer</u>

As illustrated in Figure 3-7 (see Section 3.4) and as described in NUREG–2176 (NRC 2016a), the Biscayne aquifer is the principal aquifer beneath southeast Florida that is used for water supply. It extends from the land surface to a depth of approximately 140 feet (43 m) beneath the Turkey Point, Units 3 and 4 site. It is generally an unconfined (water table) aquifer, but it may be semiconfined or confined on a localized basis due to the occurrence of less permeable strata (FPL 2018f, NRC 2016a).

Section 2.3.1.2, "Hydraulic Properties of Biscayne Aquifer," of NUREG–2176 (NRC 2016a) describes the permeable limestones and calcareous sandstones forming the Biscayne aquifer as highly heterogeneous with varying hydraulic properties that may comprise one or more aquifers separated by locally confining units. Section 2.3.1.2 of NUREG-2176 also describes the differences and the inherent hydrogeologic properties of the Biscayne aquifer including porosity, transmissivity, and hydraulic conductivity (NRC 2016a: 2-49-2-51). The NRC staff incorporates that information into this SEIS by reference.

The low topographic relief of the Turkey Point site relative to sea level makes the site subject to tidal inundation. As such, the waters of the Biscayne aquifer are highly saline below the Turkey Point site. To the east of the site, the Biscayne aquifer is recharged by the saline waters of Biscayne Bay. Freshwater recharge of the Biscayne aquifer occurs from precipitation primarily during the wet season (June to October) with minimal recharge during the dry season (November to May). It is likely that some freshwater recharge also occurs during the wet season from freshwater marshes and sheet flow runoff. Seepage from freshwater canals usually continues to recharge the aquifer during the dry season (NRC 2016a). In general, the Biscayne aquifer water table responds rapidly to precipitation as well as to tidal fluctuations (FPL 2018f).

Under natural conditions and with adequate inland recharge of freshwater, the water table in a surficial aquifer like the Biscayne aquifer is higher than the average sea-level elevation, which balances the higher density of seawater. In such a case, the freshwater-saltwater interface (interface), the most inland point marking the diffusion boundary between freshwater and seawater, is relatively stable near the coastline or offshore. This is conceptually illustrated in Figure 3-16.



Source: Barlow 2003

Figure 3-16 Generalized Diagram of the Freshwater-Saltwater Interface in a Coastal Water Table Aquifer

When the aquifer water table is lowered by pumping or canal drainage, saltwater can move inland, usually at the base of the aquifer because of the higher density of seawater relative to freshwater. Prior to urban and agricultural development and the construction of canals to drain inland areas, wet season recharge to groundwater was greater than it is today and subsurface flows of groundwater into Biscayne Bay adjacent to the Turkey Point site were also higher (NRC 2016a).

Regionally, reduced surface water runoff and groundwater discharge to Biscayne Bay, combined with pumping of groundwater for irrigation, water supply, and other uses, has caused saltwater to migrate inland along the base of the Biscayne aquifer. This process is known as saltwater intrusion or encroachment (FPL 2018f, NRC 2016a).

The Turkey Point cooling canal system (CCS) (described in Section 3.1.3, "Cooling and Auxiliary Water Systems") is a large, enclosed, hypersaline (i.e., having a salinity greater than that of natural seawater, with chloride concentration exceeding 19,000 mg/L) water body, formed by excavation into the underlying bedrock. The CCS affects the hydrology and groundwater quality of the Biscayne aquifer. The CCS is unlined and hydraulically connected to the upper Biscayne aquifer because permeable aquifer strata permit the movement of water between the aquifer and the CCS. The rate and direction of this water movement depend on the head differences between the CCS and the Biscayne aquifer, hydraulic conductivity of the CCS sediments, and fluid density differences between fluids in the CCS and the Biscayne aquifer (FPL 2018f, NRC 2016a). Because of the movement of the hypersaline CCS water into the Biscayne aquifer, there is an area of higher salinity water in the aquifer beneath the CCS and adjoining portions of the Turkey Point site, called the hypersaline plume. As FPL describes in its environmental report, over the operational life of the CCS, the annual average salinity of both the waters within the CCS and within the hypersaline plume beneath it in the Biscayne aquifer have increased. Over the operational life of the CCS, the size of the hypersaline plume has also grown larger. In its environmental report, FPL states that the hypersaline plume extends out approximately 1.5 mi (2.4 km) west of the CCS boundary (FPL 2018f). The latest published FPL annual monitoring report (2018) states that hypersaline groundwater in the Biscayne aquifer extends out about 1.5 to 2.5 mi (2.4 to 4 km) west of the CCS (FPL 2018o).

In the wider vicinity of Turkey Point, the regional groundwater flow in the Biscayne aquifer is generally to the east towards the coast. However, more directly under and near the Turkey Point site, groundwater flow is affected locally by tides and drainage canals (NRC 2016a). In the NRC staff's EIS for the Turkey Point Units 6 and 7 combined licenses, Section 2.3.1.2, "Groundwater Flow Direction," (NUREG–2176) (NRC 2016a) describes in some detail the complex flow interactions between the CCS, the operation of the CCS interceptor ditch and adjacent L-31E Canal, and the hydrologic and density-driven dynamics of the hypersaline plume. As mentioned in the previous paragraph and further described below, the hypersaline plume has grown in size and moved laterally beyond the CCS and the bordering L-31E Canal within the deeper part of the Biscayne aquifer, predominantly to the west. The NRC staff incorporates the information in Section 2.3.1.2 of the COL EIS here by reference (NRC 2016a: 2-51, 2-53). In this SEIS, Section 3.1.3.2, "Cooling Canal System (CCS)," describes the interceptor ditch. The current extent of the hypersaline plume emanating from the CCS and its effects on groundwater quality and saltwater intrusion are further discussed below in Section 3.5.2.2, "Groundwater Quality" (see "Baseline Groundwater Quality and Changes Attributable to Turkey Point Operations").

<u>Intermediate Confining Unit</u>

Separating the surficial Biscayne aquifer and the Floridan aquifer system is the hydrogeologic unit called the Intermediate Confining Unit (see Figure 3-7 in Section 3.4). This unit has a generally low permeability and is over 800 feet (240 m) thick beneath the Turkey Point site. It is comprised of extensive layers of clay-rich sediments in the upper part of the unit (NRC 2016a). Sands and limestone lenses comprise the permeable parts of this unit (Figure 3-7). Site information suggests that the thickness ranges from approximately 700 feet (210 m) just to the north of the Turkey Point site (at Unit 5 production well PW-3) to about 1,000 feet (300 m) southwest of the site. On a regional scale, the Intermediate Confining Unit serves as an effective aquiclude (an impermeable layer or rock or stratum or sediment) for the Floridan aquifer system throughout the state of Florida (FPL 2018f).

Floridan Aquifer System

The Floridan aquifer system underlies the Intermediate Confining Unit. The system is composed principally of dolomite and limestone and is under confined conditions beneath the Turkey Point site and throughout southeastern Florida. The Floridan aquifer system at the Turkey Point site principally consists of the Upper Floridan aquifer, a middle confining unit, and the saline Lower Floridan aquifer (FPL 2018f, NRC 2016a) (Figure 3-7).

The Upper Floridan aquifer is composed of several thin water-bearing zones interlayered with thick zones of low permeability. Across most of Florida, it is a major source of potable water; however, in southeastern Florida, including Miami-Dade County, the water is brackish and requires treatment to meet drinking water standards. While the aquifer can be 400 feet (120 m) or more in thickness across southeastern Florida, at the Turkey Point site, it is approximately 200 feet (60 m) thick (FPL 2018f). Regionally, groundwater flow in the aquifer is generally west to east across the site toward the coast. This is confirmed by groundwater level data from Upper Floridan aquifer wells located near the Turkey Point site (FPL 2018f, NRC 2016a).

The middle confining unit within the Floridan aquifer system consists of beds of less permeable strata that are more than 1,000 feet (300 m) thick, separating the aquifers above and below (FPL 2018f). As described in Section 2.3.1.2 of NUREG–2176, the middle (Floridan) confining unit generally contains a relatively thin, permeable zone called the Avon Park Permeable (or Producing) Zone (APPZ), and a lower confining zone (see Figure 3-7 in Section 3.4 of this SEIS). However, the Avon Park zone thins to the south and was not identified at the EW-1 exploratory well at Turkey Point (NRC 2016a).

The upper part of the Lower Floridan aquifer is comprised of low permeability (confining layer) rocks; the deeper part of the Lower Floridan aquifer is a well-developed, highly permeable karst region of fractured carbonate rock known as the Boulder Zone (FPL 2018f, NRC 2016a). The high permeability of the Boulder Zone has been attributed to a network of horizontal caverns at varying depths connected by vertical tubes. Water quality in the Boulder Zone is similar to modern seawater. Within the Boulder Zone, it appears that seawater moves westward from a connection with the Atlantic Ocean off the coast at a depth of about 2,500 feet (760 m). At the Turkey Point site, the top of the Boulder Zone is found at a depth of 3,030 feet (994 m). This depth is consistent with statewide mapping (NRC 2016a).

3.5.2.2 Groundwater Quality

Groundwater Quality Standards and Current Designated Uses

The FDEP classifies groundwater within the State of Florida according to present and future “most beneficial uses.” The State of Florida establishes water quality standards to protect designated uses (FAC R62-520.300). Florida categorizes groundwater in one of five classes

(FAC R62-520.410). These five classes generally relate to the level of potability (i.e., use for drinking and related purposes) as determined by total dissolved solids (TDS) content.

- Class F-I: Potable water use, groundwater in a single source aquifer described in FAC R62 520.460, with a total dissolved solids content of less than 3,000 mg/L and specifically reclassified as Class F-I by the Florida Environmental Regulation Commission.
- Class G-I: Potable water use, groundwater in a single source aquifer that has a total dissolved solids content of less than 3,000 mg/L and specifically reclassified by the Florida Environmental Regulation Commission.
- Class G-II: Potable water use, groundwater in aquifers with a total dissolved solids content of less than 10,000 mg/L, unless otherwise classified by the Florida Environmental Regulation Commission.
- Class G-III: Nonpotable water use, groundwater in unconfined aquifers with a total dissolved solids content of 10,000 mg/L or greater; or with a total dissolved solids content of 3,000-10,000 mg/L and either reclassified by the Florida Environmental Regulation Commission as having no reasonable potential as a future source of drinking water or designated by the FDEP as an exempted aquifer.
- Class G-IV: Nonpotable water use, groundwater in confined aquifers with a total dissolved solids content of 10,000 mg/L or greater.

The State of Florida provides single-source aquifers—those aquifers it identifies as the only reasonably available source of potable water to a significant segment of the population—with the highest level of protection. The FDEP designates such aquifers as Class F-1 and G-I, which have TDS concentrations of less than 3,000 mg/L (FAC R62-520.410). For comparison, the Federal drinking water standard or secondary maximum contaminant level (MCL) for TDS is 500 mg/L (40 CFR 143.3). This secondary standard is based on aesthetic considerations (i.e., taste, color, and odor) and the constituent does not present a risk to human health at the specified level. The FDEP has adopted the same secondary standard for Florida drinking water (FDEP 2018b).

Beneath the Turkey Point site and across southeastern Miami-Dade County, the quality of groundwater within the Biscayne and Floridan aquifer systems varies greatly due to the interaction of natural as well as human-induced factors over time. This is most apparent in the surficial Biscayne aquifer as saltwater intrusion (encroachment) has occurred under a large area of the southeast Florida coast, including under the Turkey Point site.

The NRC staff's EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG–2176) (NRC 2016a) cites a U.S. Geological Survey (USGS) study (Prinos et al. 2014) investigating the origins and extent of saltwater intrusion in the Biscayne aquifer. In the study, the USGS presented its analysis of tritium measurements from USGS monitoring wells within about 6 mi (10 km) of the Turkey Point site, which indicated that water from the CCS may contribute to saltwater encroachment in areas northwest of the CCS (Prinos et al. 2014).

FPL states in its environmental report (FPL 2018f) that, even before construction of the CCS in the mid-1970s, the Biscayne aquifer near the Turkey Point site was saline for the full depth of the aquifer, and saltwater intrusion into the Biscayne aquifer had already occurred several miles inland (FPL 2018f). This is supported by information in the NRC staff's EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG–2176), Section 2.3.3.2 and Figure 2-22. The NRC staff incorporates Section 2.3.3.2 and Figure 2-22 of NUREG–2176 into this SEIS by reference. NUREG–2176, Figure 2-22 depicts various mapped estimates by the USGS and others of the saltwater interface over the period of 1951 to 2008. These USGS historic estimates depict interface locations that are no less than about 4 mi (6.6 km) west and northwest of the CCS. NUREG–2176, Section 2.3.3.2 contains the NRC staff's characterization of factors contributing to saltwater intrusion, including contributions from the CCS (NRC 2016a: 2-68, 2-69).

Inland migration of the saltwater interface within the Biscayne aquifer continues across the region. Based on a recent USGS estimate, the saltwater interface has moved inland across portions of southeastern Miami-Dade County, west and north of the Turkey Point site, at an average rate of 460 feet (140 m) per year (Prinos 2017). Figure 3-17 below depicts the current location of the saltwater interface at the base of the Biscayne aquifer in relation to the Turkey Point site, the CCS, groundwater monitoring wells maintained by FPL, and other features. The saltwater interface is currently located about 4.7 mi (7.6 km) west of the CCS at its closest point, based on the latest (2017) USGS monitoring well data. The mapped location reflects the current estimate of the 1,000 mg/L concentration boundary for chloride at the base of the Biscayne aquifer (Prinos 2017).

In 1983, the FDEP designated as Class G-III (i.e., non-potable use with TDS levels of 10,000 mg/L or greater) the surficial groundwater (Biscayne aquifer) within the Turkey Point plant property, with the west side of the CCS marking the western boundary (FPL 2018f, SFWMD 2009). The FDEP has classified surficial groundwater west of the Turkey Point site (i.e., to the west of the site boundary and CCS) as Class G-II, which means potable water use, with TDS levels of less than 10,000 mg/L (FPL 2018f). The intersection of Class G-II and underlying Class G-III groundwater marks the saltwater interface (FDEP 2016a).

In 2014, the FDEP issued an administrative order to FPL. In this 2014 administrative order, the findings of fact state that saltwater was present as early as the 1940s near the base of the Biscayne aquifer west of the Turkey Point site. It further states that groundwater data from the early 1970s (prior to completion of CCS construction in 1973) supported the determination that non-potable groundwater (TDS exceeds 10,000 mg/L) occurred beneath much of the proposed CCS at depth and within the deeper portions of the aquifer west of the site (FDEP 2014).

Through wells located inland of the saltwater interface, the Biscayne aquifer is the major public water supply source across Miami-Dade County as well as for the Florida Keys, supplied by the Florida Keys Aqueduct Authority (FKAA 2019a; NRC 2016a: 2-60). In addition, the EPA has designated the Biscayne aquifer across all of south Florida as a sole-source aquifer pursuant to Section 1424(e) of the Safe Drinking Water Act of 1974 (EPA 2016a, FPL 2018f, NRC 2016a).

The Biscayne aquifer is not the only current or potential source of drinking water in the region. The Upper Floridan aquifer is also an important source of freshwater in parts of Florida. The FDEP designates the Upper Floridan aquifer as an underground source of drinking water because its water has a TDS concentration of less than 10,000 mg/L (FAC R62-528.200, NRC 2016a). However, while the groundwater within the Upper Floridan aquifer contains less than 10,000 mg/L TDS in southeastern Florida, with TDS concentrations greater than 2,000 mg/L, water obtained from the aquifer is too saline to be used for drinking water without treatment (NRC 2016a).

Source: Modified from FPL 2018o: Fig. 1.1-2 and FPL 2018p: Fig. 2.4-1

Figure 3-17 Groundwater Monitoring Locations and Saltwater Interface, Turkey Point Site

Baseline Groundwater Quality and Changes Attributable to Turkey Point Operations

The SEIS for the Turkey Point Units 3 and 4 initial license renewal (NUREG–1437, Supplement 5) (NRC 2002c) documents the NRC staff's environmental review of FPL's application for the initial 20-year license renewal submitted in 2000. Section 2.1.3 of that EIS describes the likely exchange between the canals and groundwater as well as the operation of the CCS and associated interceptor ditch. As stated therein, the operation of the interceptor ditch was intended to prevent the flow of hypersaline water from the cooling canals toward the Everglades (i.e., inland to the west) (NRC 2002c).

Thus, when the NRC staff published its SEIS for the Turkey Point initial license renewal in 2002, the staff acknowledged the existence of a hypersaline plume in the Biscayne aquifer directly beneath the CCS. What was not fully understood at the time was the potential for the hypersaline plume to migrate vertically downward through the Biscayne aquifer and then to move laterally within the Biscayne aquifer beyond the CCS boundaries. The following discussion presents new information on the effects of CCS operations on hypersalinity in the Biscayne aquifer and groundwater quality.

The interaction of water in the CCS (including cooling loop water and stormwater from Turkey Point) with underlying groundwater in the Biscayne aquifer is complex. In the CCS, heat is rejected to the atmosphere primarily through evaporation, resulting in a net loss of water from the canals. As water evaporates from the CCS, the concentration of dissolved substances, principally salts, in the CCS increases. This increases the density of the CCS water. The high rate of evaporation also produces a net inflow of groundwater into the CCS, but the groundwater flux between the CCS and Biscayne aquifer varies by location. The following variables and factors also affect these groundwater interactions between CCS waters and Biscayne aquifer waters:

- precipitation, specifically seasonal precipitation variation during the wet season versus the dry season
- variations in hydraulic head (water table elevation)
- cooling water effluent discharge rate
- air temperature
- humidity
- tidal fluctuations

As a result of the above variables, the direction of water movement into or out of the CCS varies in time and space. Over time, the denser, heated, hypersaline water migrates downward from the CCS into the Biscayne aquifer. The downward movement of hypersaline water is impelled by the increased density because of the elevated salinity of the water in the CCS (NRC 2016a).

In preparing the EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG–2176) (NRC 2016a), the NRC staff reviewed modeling performed by Hughes et al. (2010), which used a two-dimensional, cross-section model to evaluate the combined effects of salinity, temperature, and other variables associated with operation of the CCS, including the CCS's contribution to the movement of the saltwater interface. The Hughes modeling demonstrates that the downward migration of hypersaline water takes the form of "finger plumes" that form beneath the CCS and then move downward to the bottom of the permeable zone of the aquifer in a period ranging from days to several years, depending on localized differences in aquifer properties. These finger plume structures then mix with aquifer water through advection and dispersion (NRC 2016a). The modeling also indicates that the inland migration of the saltwater interface is closely related to TDS concentrations in the CCS (Hughes et al. 2010).

FPL operates the interceptor ditch to maintain an eastward hydraulic gradient in the near surface groundwater (toward the CCS). However, this operation has not completely prevented the hypersaline CCS water that enters the Biscayne aquifer from migrating westward in the deeper part of the aquifer. This is primarily because the interceptor ditch only functions to the depth to which it was constructed, as described in Section 3.1.3.2, "Cooling Canal System (CCS)," thus enabling hypersaline water that has moved to deeper depths in the aquifer to move beyond and west of the interceptor ditch. Five historical wells (i.e., L-3, L-5, G-21, G-28, and G-35), shown in Figure 3-17, have been monitored since the 1970s to assess the impact of interceptor ditch operation on Biscayne aquifer water quality (FPL 2018o).

Since 2010, FPL has maintained an extensive, multimedia environmental (uprate-related) monitoring program in accordance with Turkey Point's site certification conditions (i.e., Conditions IX and X), as modified (FDEP 2016b, State of Florida Siting Board 2016) pursuant to the Florida Power Plant Siting Act and related regulatory requirements, stemming from the NRC's June 2012 approval of the Turkey Point extended power uprate project. The focus of this uprate monitoring program is to determine the horizontal and vertical effects of CCS water on the environment. FPL conducts this program in part in accordance with the 2009 monitoring plan (SFWMD 2009) under the auspices of the FDEP, SFWMD, and the Miami-Dade County Department of Environmental Resources Management (DERM).

FPL completed a period of pre-uprate monitoring in 2012, covering the period of June 2010 through June 2012, and submitted it for interagency review in October 2012 (FPL 2018f, FPL 2012a). Monitoring results are reported in publicly available annual monitoring reports submitted to the FDEP and partner agencies including the SFWMD and Miami-Dade County. Data and reports are also accessible through FPL's Electronic Data Management System (EDMS; https://www.ptn-combined-monitoring.com). To date, the results of FPL's groundwater uprate monitoring demonstrate that CCS operations have impacted groundwater quality in the Biscayne aquifer to the west of the L-31E Canal as well as beneath Biscayne Bay to the east (NRC 2016a).

For the uprate groundwater monitoring, FPL's contractor has performed quarterly to semiannual field sampling from 14 well clusters, comprising 42 wells in total. This is in addition to automated water quality and water level measurements at each well (FPL 2017a). Each well cluster consists of three, collocated Biscayne aquifer monitoring wells (i.e., shallow, intermediate, and deep), which are shown above in Figure 3-17. For each monitoring well, FPL collects and analyzes groundwater samples for 29 separate parameters, including general water quality parameters (e.g., temperature, pH), ionic, and nutrient constituents. Tritium is used as a chemical tracer in order to determine the potential movement of CCS water within the Biscayne aquifer (FPL 2017a, FPL 2018o; SFWMD 2009). Specifically, by interagency consensus, tritium was established as a tracer for the CCS water with a threshold concentration value for tritium of 20 pCi/L in groundwater (FPL 2012a).

More recently, between 2015 and 2018, FPL expanded its groundwater monitoring network in accordance with provisions of the 2016 FDEP Consent Order (FDEP 2016a); the 2015 Consent Agreement, as amended, with Miami-Dade County (MDC 2015a); and related requirements (see "Regulatory Developments with Respect to Cooling Canal System Operations and

Groundwater Quality" in this section for more information on these documents) (FPL 2018o, FPL 2018p). The first set of new well clusters (TPGW-15 and TPGW-16) was installed in accordance with FPL's Miami-Dade Class I permit CLI-2014-0312 (FPL 2018o). Well clusters TPGW-15 and TPGW-16 are located near the northwest and east-central boundaries of the CCS, respectively (FPL 2018o). FPL has also installed three monitoring well clusters in the Model Lands Basin, located approximately 2 miles (3.2 km) west of the CCS. These three new wells are designated TPGW-17, TPGW-18, and TPGW-19 (Figure 3-17). Additionally, FPL replaced monitoring well TPGW-8S, and constructed a new deep monitoring well (TPGW-20D) in the city of Homestead's baseball complex (near Miami-Dade County's Newtown Wellfield). These well construction activities were completed between September 2017 and March 2018. All of the wells are of similar design and function as the existing groundwater monitoring wells across the region, and sampling/monitoring is generally conducted in accordance with the 2009 monitoring plan (SFWMD 2009). FPL has also added monitoring data from six existing USGS wells (G-3946-S, G-3946-D, G-3900, G-3976, G-3966, and G-3699) to the EDMS (FPL 2018p).

Meanwhile, FPL, Miami-Dade County, and the FDEP have been working on potential revisions to the 2009 monitoring plan that would affect the monitoring required under the 2016 FDEP Consent Order (FDEP 2016a) and the 2015 Consent Agreement with Miami-Dade County (MDC 2015a). FPL reports that this revised monitoring plan could be finalized in 2019 (FPL 2018p).

Table 3-4 below summarizes the latest available analytical results for select wells and key monitored parameters. It provides a snapshot of groundwater quality at specific intervals at discrete locations over time.

Table 3-4 Summary of Groundwater Monitoring Results for Key Water Quality Parameters in Select Biscayne Aquifer Wells, Turkey Point Uprate Monitoring Program, 2011 (Preuprate) and 2018

Well Number and Period [a,b,c]	Chloride (mg/L)	TDS (mg/L)	Salinity (PSU)	Tritium (pCi/L)	Ammonia (mg/L)
TPGW-1S (2018)	19,400	34,000	32.37	954	1.35
TPGW-1M (2018)	27,000	51,200	48.46	2,173	1.75
TPGW-1D (2018)	28,500	51,8000	48.03	2,307	1.84
TPGW-1S (2011)	17,000	27,000	27.8	810	0.87
TPGW-1M (2011)	29,000	49,000	48.7	2,440	1.3
TPGW-1D (2011)	29,000	50,000	48.1	2,560	1.3
TPGW-2S (2018)	24,800*-	44,400	42.78	2,166	1.57
TPGW-2M (2018)	29,500*	52,800	50.89	3,130	3.14
TPGW-2D (2018)	31,300	52,400	51.56	3,123	2.68
TPGW-2S (2011)	30,000	50,000	52.4	3,030	1.5
TPGW-2M (2011)	34,000	52,000	50.7	3,520	1.5
TPGW-2D (2011)	32,000	52,000	54.2	3,320	1.7
TPGW-4S (2018)	2,280	4,320	4.08	17.4	M
TPGW-4M (2018)	15,100	27,400	25.38	342	M
TPGW-4D (2018)	14,800	27,500	26.34	403	M
TPGW-4S (2011)	670	1,400	1.4	19.4	M

TPGW-4M (2011)	13,000	22,000	24.0	246	M
TPGW-4D (2011)	16,000	26,000	28.0	519	M
TPGW-7S (2018)	37.0	292	0.25**	6.6	M
TPGW-7M (2018)	40.0	294	0.25*	5.2	M
TPGW-7D (2018)	3,970*	7,350	5.85*	20.3	M
TPGW-7S (2011)	35	300	0.3*	13.5	M
TPGW-7M (2011)	35	300	0.3*	12.9	M
TPGW-7D (2011)	42	310	0.3*	2.2	M
TPGW-9S (2018)	25.3	332	0.29*	5.7	M
TPGW-9M (2018)	26.1	326	0.29*	6.5	M
TPGW-9D (2018)	26.3	352	0.30*	1.5	M
TPGW-9S (2011)	20	330	0.3*	10.6	M
TPGW-9M (2011)	25	350	0.3*	8.2	M
TPGW-9D (2011)	28	350	0.3*	1.5*	M
TPGW-10S (2018)	18,900	35,600	35.91	69.1	0.43
TPGW-10M (2018)	19,600	41,600	36.67	208	0.47
TPGW-10D (2018)	28,000	50,800	48.04	1,798	1.38
TPGW-10S (2011)	19,000	33,000	33.8	18.4	0.32
TPGW-10M (2011)	22,000	37,000	37.0	2.8*U	0.24
TPGW-10D (2011)	22,000	36,000	37.4	8.2	0.22
TPGW-11S (2018)	20,700	40,800	36.49	5.7	M
TPGW-11M (2018)	22,500	38,000	38.98	277	M
TPGW-11D (2018)	24,300	48,000	45.55	1,158	M
TPGW-11S (2011)	22,000	36,000	36.9	2.4	M
TPGW-11M (2011)	23,000	39,000	37.8	33.6	M
TPGW-11D (2011)	24,000	39,000	39.3	435	M
TPGW-13S (2018)	32,800	58,600	57.86	6,016	5.58
TPGW-13M (2018)	32,700	58,400	56.52	3,277	3.40
TPGW-13D (2018)	33,700	62,800	58.48	3,130	3.36
TPGW-13S (2011)	38,000*	61,000	61.6	3,800	2.8
TPGW-13M (2011)	37,000*	57,000	58.5	4,030	1.6H
TPGW-13D (2011)	37,000*	59,000	59.2	3,830	1.6
TPGW-14S (2018)	21,200	43,400	38.45	93.1	0.54
TPGW-14M (2018)	21,500	45,000	40.01	175	0.80
TPGW-14D (2018)	28,700	52,800	49.46	2,083	2.42
TPGW-14S (2011)	24,000	39,000	40.0	247	0.54
TPGW-14M (2011)	27,000	43,000	43.6	772	0.84
TPGW-14D (2011)	32,000*	52,000	51.8	2,660	1.6*-

Notes: D=deep well; M=middle well (intermediate interval); S=shallow well; TDS=total dissolved solids; H=hold time exceeded; *=denotes result qualified as estimated (+/- indicates bias); M=missing data (analyte not collected/required); U=indicates analyzed for but not detected at the reported value.

Some results in the table may be rounded.

(a) All units are reported in milligrams per liter (mg/L) except salinity (reported in practical salinity units (PSU) based on the practical salinity scale of 1978) (unitless) and tritium (picoCuries per liter (pCi/L) with 1σ uncertainty error omitted). Ammonia is reported as total ammonia nitrogen.

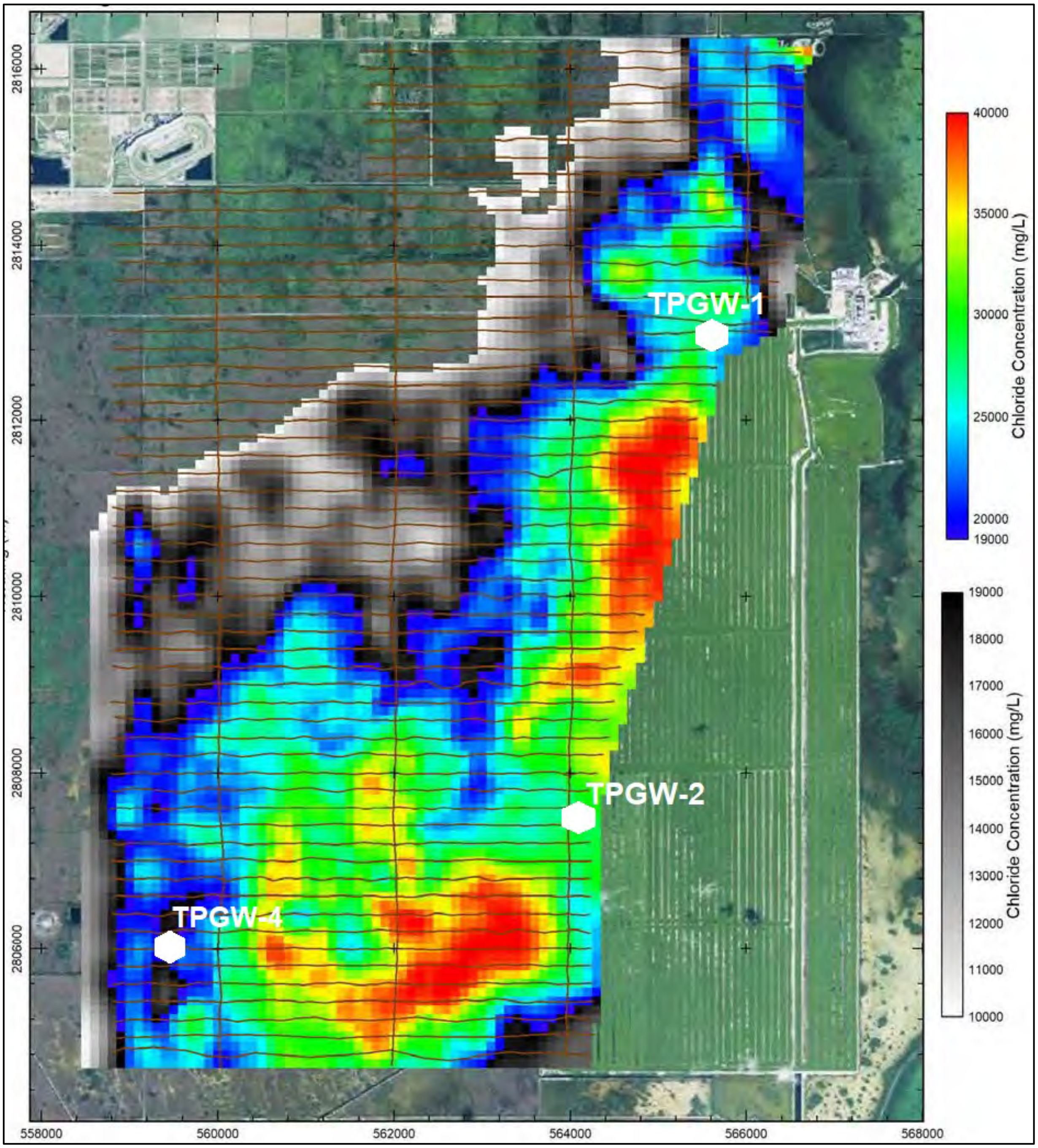
(b) Analytical results from the March 2018 quarterly sampling event (FPL 2018o).

(c) Analytical results from the March 2011 quarterly sampling event (FPL 2012a).

Source: FPL 2012a, FPL 2017a, FPL 2018o.

Monitoring well locations (see Figure 3-17) were established based on FPL and interagency consensus and criteria as documented in the 2009 monitoring plan (SFWMD 2009). The wells are located such that monitoring will be able to detect changes in groundwater quality, including migration of the hypersaline plume, both in the near field (adjacent to the CCS) and at representative far-field locations (i.e., at distances not currently identified as having been affected by CCS water). For example, well cluster TPGW-13 is located at the approximate center of the CCS, the source of the hypersaline plume. Wells TPGW-1 through TPGW-7 are situated at various distances to the north and west of the CCS. Well cluster TPGW-7, when originally installed, was established as the FPL uprate monitoring location nearest to the Miami-Dade County's Newton Wellfield that supplies potable water to municipal customers. However, a new monitoring well (TPGW-20D), described above, is closer to the Newton Wellfield as are several wells maintained by the USGS, for which monitoring data are now being included in FPL's EDMS. Well location TPGW-9 is a reference well location reflecting groundwater conditions unaffected by the CCS and located upgradient (west) of the saltwater interface. Well locations TPGW-10, TPGW-11, and TPGW-14 are offshore in Biscayne Bay and Card Sound.

As summarized in Table 3-4 above, the analytical results from FPL's monitoring program include the deep-screened interval of the listed well locations that correspond to the base of the Biscayne aquifer, the intermediate (middle) screened-interval, as well as from the shallow (upper) interval of the aquifer, in order to identify any vertical differences in water quality parameters. It is in the lower intervals of the aquifer where hypersaline water from the CCS would be expected to preferentially move, as well as where migration of the regional saltwater interface would first be evident. Based on the results from FPL's baseline continuous surface electromagnetic survey conducted in late March and early April 2018, the hypersaline groundwater plume is generally wedge-shaped. Consequently, the hypersaline groundwater does not extend as far west in the shallow and deeper intervals of the Biscayne aquifer as it does in the intermediate interval of the aquifer. While FPL correctly states that the plume generally extends an average of 1.5 to 2.5 miles (2.4 to 4.0 km) west of the CCS (FPL 2018o), more precisely the hypersaline groundwater extends about 1 mile (1.6 km) west of the CCS at the base of the Biscayne aquifer (i.e., at 87.0 to 99.4 ft (26.5 to 30.3 m) below land surface) and about 3 miles (4.8 km) west of the CCS in a high-flow interval at depths from 47 to 55 ft (14.3 to 16.8 m) below ground surface (FPL 2018q). At more shallow depths (26 to 32 ft (7.9 to 9.8m)), the plume extends about 1.2 miles (1.9 km) west from the southern portion of the CCS. Figure 3-18 depicts the mapped areal extent from the 2018 continuous surface electromagnetic survey of chloride concentration in the Biscayne Aquifer in the high-flow interval. The extent of hypersaline groundwater is shown by the interface between the black and blue colors. The approximate locations of select monitoring wells have been added to Figure 3-18 for reference.



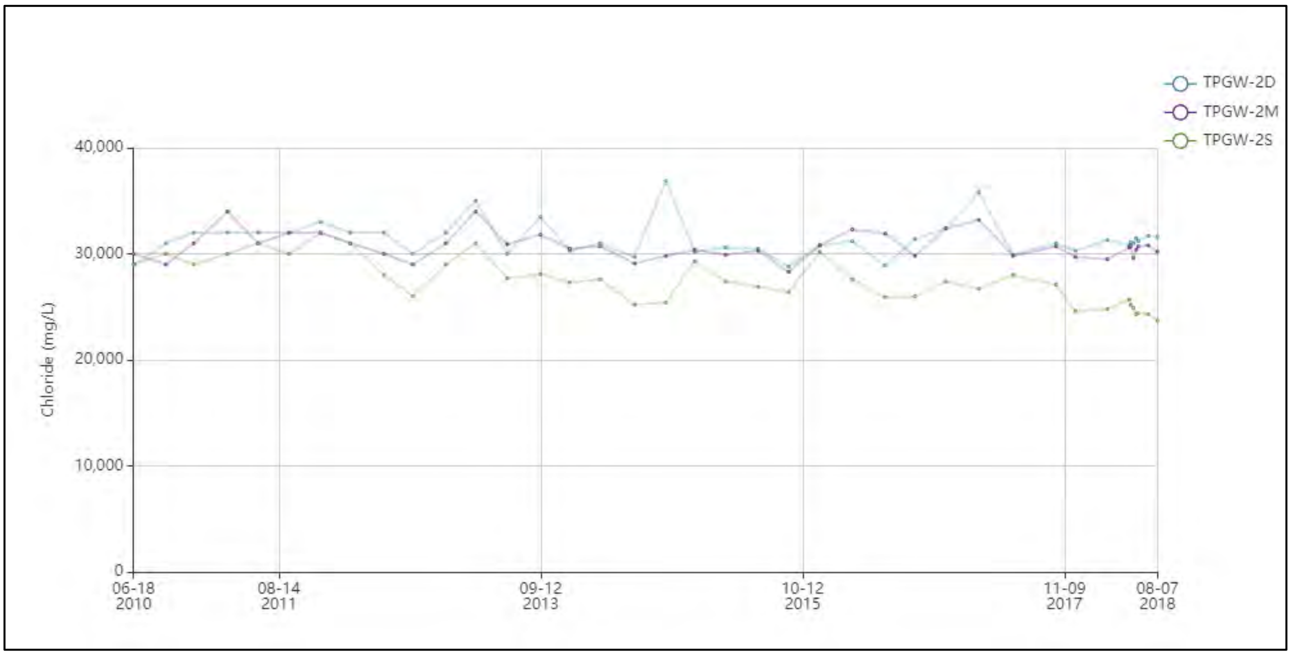
Source: Modified from FPL 2018q: App G Fig. 3-2 (well locations are approximate)

Figure 3-18 Chloride Concentration and Extent of Hypersalinity in the Biscayne Aquifer, 44 to 55 ft Below Ground Surface April 2018

Further, Table 3-4 compares quarterly groundwater sampling results for the same seasons (i.e., March 2011 and March 2018) so that results for monitored parameters at the well locations can be compared. March is near the end of the dry season across southeast Florida and is the timeframe where the effects of CCS water incursion would likely be more discernible. Data from March 2011 are included to provide a baseline from the pre-extended power uprate monitoring period (June 2010 to June 2012) for comparison with recent monitoring results for Turkey Point. In addition to Table 3-4, the NRC staff has included several time-series line plots to illustrate key observations and findings.

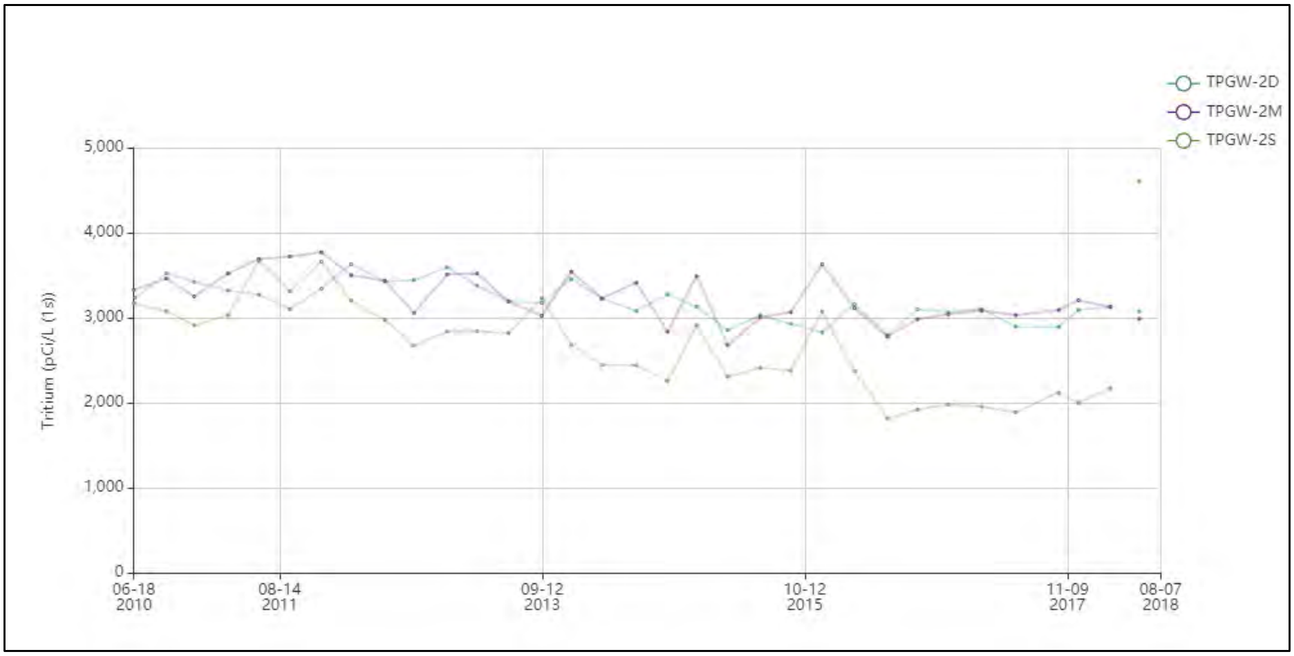
The NRC staff's data and analyses document baseline groundwater quality as well as any changes in quality in the Biscayne aquifer within and adjacent to the Turkey Point site. The results reflect the current FDEP classification for Class G-III groundwater (i.e., TDS of 10,000 mg/L or greater) in the area of the site, corresponding to the western boundary of the CCS and encompassing the Turkey Point property to the east and extending beneath Biscayne Bay (see well clusters, TPGW-10, TPGW-11, TPGW-13, and TPGW-14). The current monitoring data (Table 3-4) also establish that TDS concentrations in groundwater to the west of the CCS boundary exceed the G-II standard (TDS of less than 10,000 mg/L) in the intermediate and deeper portions of the Biscayne aquifer (see, for example, data for well clusters TPGW-2 and TPGW-4).

Monitoring results, as confirmed by the continuous surface electromagnetic survey (see Figure 3-18 above), further show the influence of CCS operations on Biscayne aquifer groundwater quality adjacent to and west of the CCS, based on the presence of hypersaline water (chloride concentrations greater than 19,000 mg/L), in addition to elevated tritium levels. As an example, Figures 3-19a and 3-19b show chloride and tritium concentrations, respectively, in monitoring well cluster TPGW-2 for the period 2010-2018.



Source: Generated from FPL 2019g

Figure 3-19a Time-Series Chart of Chloride Concentrations in Well Cluster TPGW-2, 2010-2018

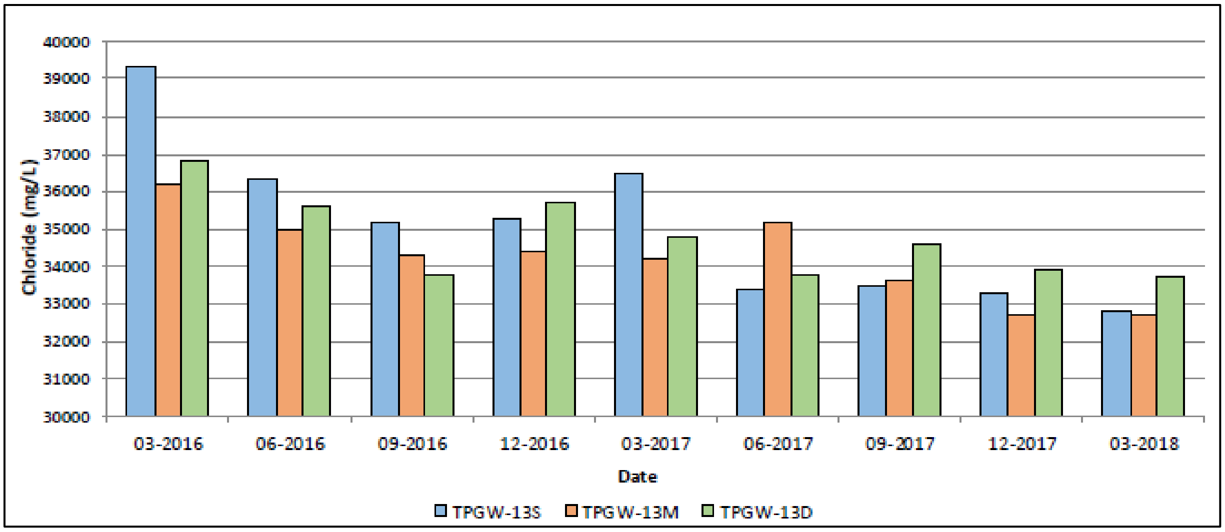


Source: Created from FPL 2019g

Figure 3-19b Time-Series Chart of Tritium Concentrations in Well Cluster TPGW-2, 2010-2018

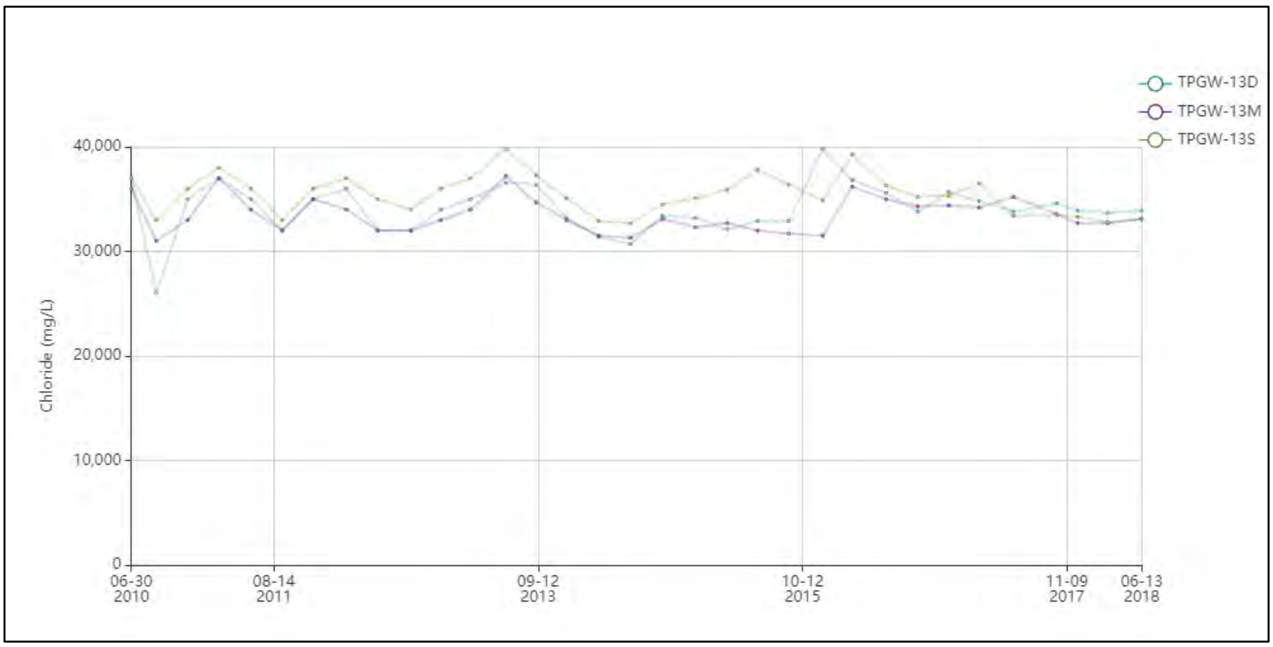
The data presented in Table 3-4, as well as in the broader quarterly monitoring data sets (June 2013 through March 2018) (FPL 2016a, FPL 2017a, FPL 2018o), generally display an increasing vertical trend in parameter concentrations, such as in chloride, TDS, and tritium, with depth (i.e., from the shallow to the deep monitored intervals). This is illustrated in Figures 3-19a and 3-19b. The NRC staff notes that Figure 3-19b reveals an apparent spike in tritium in well TPGW-2S (4,605 pCi/L) during the June 2018 sampling event, which falls outside the timeframe included in the current (2018) published annual monitoring report (FPL 2018o). This result appears to be a localized anomaly based on the NRC staff's review of monitoring data from other wells for the same timeframe. Currently available monitoring data at this well cluster do not show any sustained changes in groundwater quality at this location. Nevertheless, and as the latest annual monitoring report results affirm (FPL 2018o), concentrations tend to increase with depth in the aquifer due to the greater density of saline water and thus can be indicative of the influence of CCS water.

Well cluster TPGW-13, centered in the CCS, has the highest chloride, TDS, tritium, and ammonia concentrations, and concentrations in shallow well TPGW-13S can approach or exceed those in the deeper or intermediate wells due to the influence of CCS surface water (see Table 3-4). As shown in Figure 3-20a, groundwater monitoring indicates a recent general decline in chloride concentrations at well cluster TPGW-13 since 2016. However, this apparent trend is less pronounced over the period of record back to 2010 (Figure 3-20b).



Source: FPL 2019o: Fig. 3.1.22

Figure 3-20a Bar Graph of Chloride Concentrations in Well Cluster TPGW-13 (CCS), 2016-2018

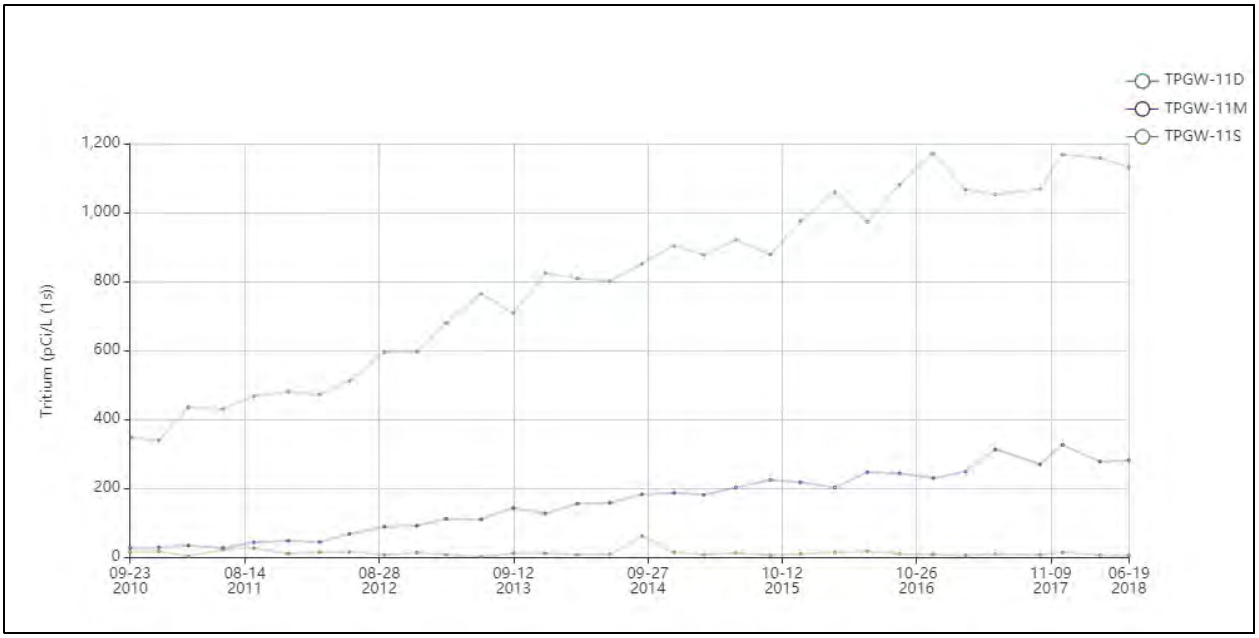


Source: Created from FPL 2019g

Figure 3-20b Time Series Chart of Chloride Concentrations in Well Cluster TPGW-13 (CCS), 2010-2018

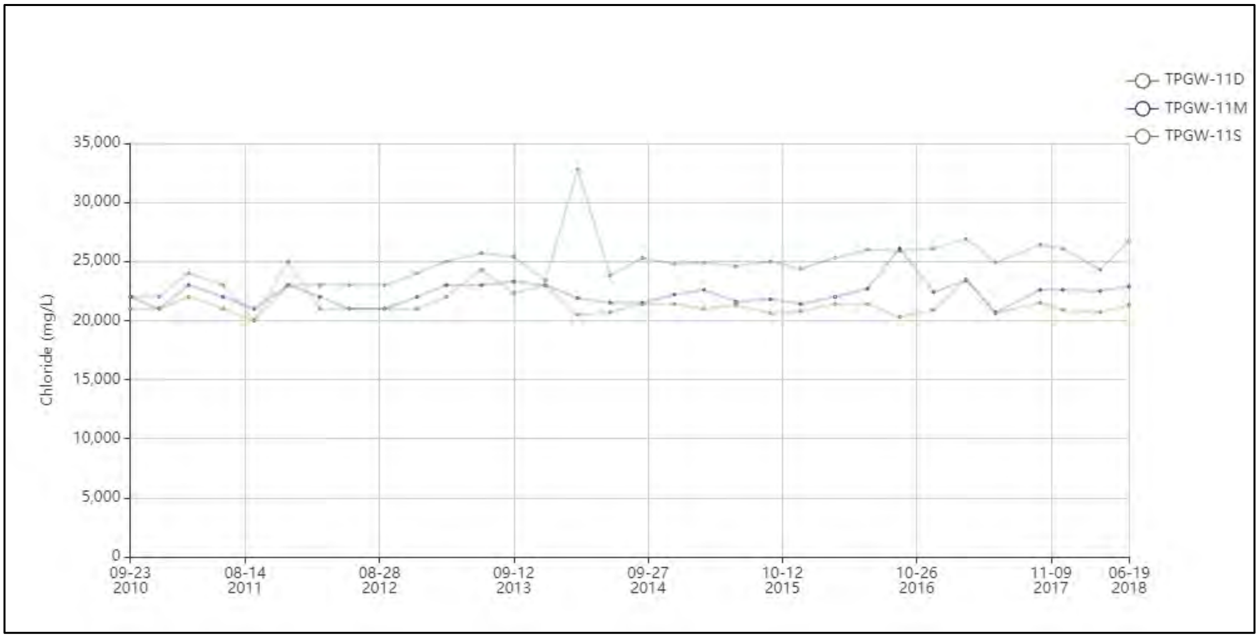
Similarly, tritium levels measured in wells to the east of the CCS in Biscayne Bay (i.e., TPGW-10, TPGW-11, and TPGW-14) suggest the influence of CCS water, at least in the deeper intervals of the Biscayne aquifer (Table 3-4), with generally very low levels of tritium found in the shallow portion of the aquifer.

For most monitored parameters at these groundwater locations (TPGW-2, -4, -10, -11, and -14), the NRC staff observes that the influence of CCS water was evident prior to implementation of the extended power uprate beginning in 2012. One exception is well cluster TPGW-10 located just northeast of the CCS in Biscayne Bay, where monitoring did not reveal elevated tritium concentrations at any depth until after 2011 (see Table 3-4 and the discussion later in this section). Figures 3-21a and 3-21b show trends in tritium and chloride, respectively, in groundwater beneath Biscayne Bay at well cluster TPGW-11. At well TPGW-11, monitoring results show an increase in tritium concentrations over time, confined to the deep and intermediate intervals of the Biscayne aquifer. There is no indication of any influence of CCS water in the uppermost interval of the Biscayne aquifer at this location. Chloride concentrations at this location have remained relatively stable at all depths, with higher chloride concentrations in the deeper portion of the aquifer.



Source: Created from FPL 2019g

Figure 3-21a Time-Series Chart of Tritium Concentrations in Well Cluster TPGW-11, 2010-2018

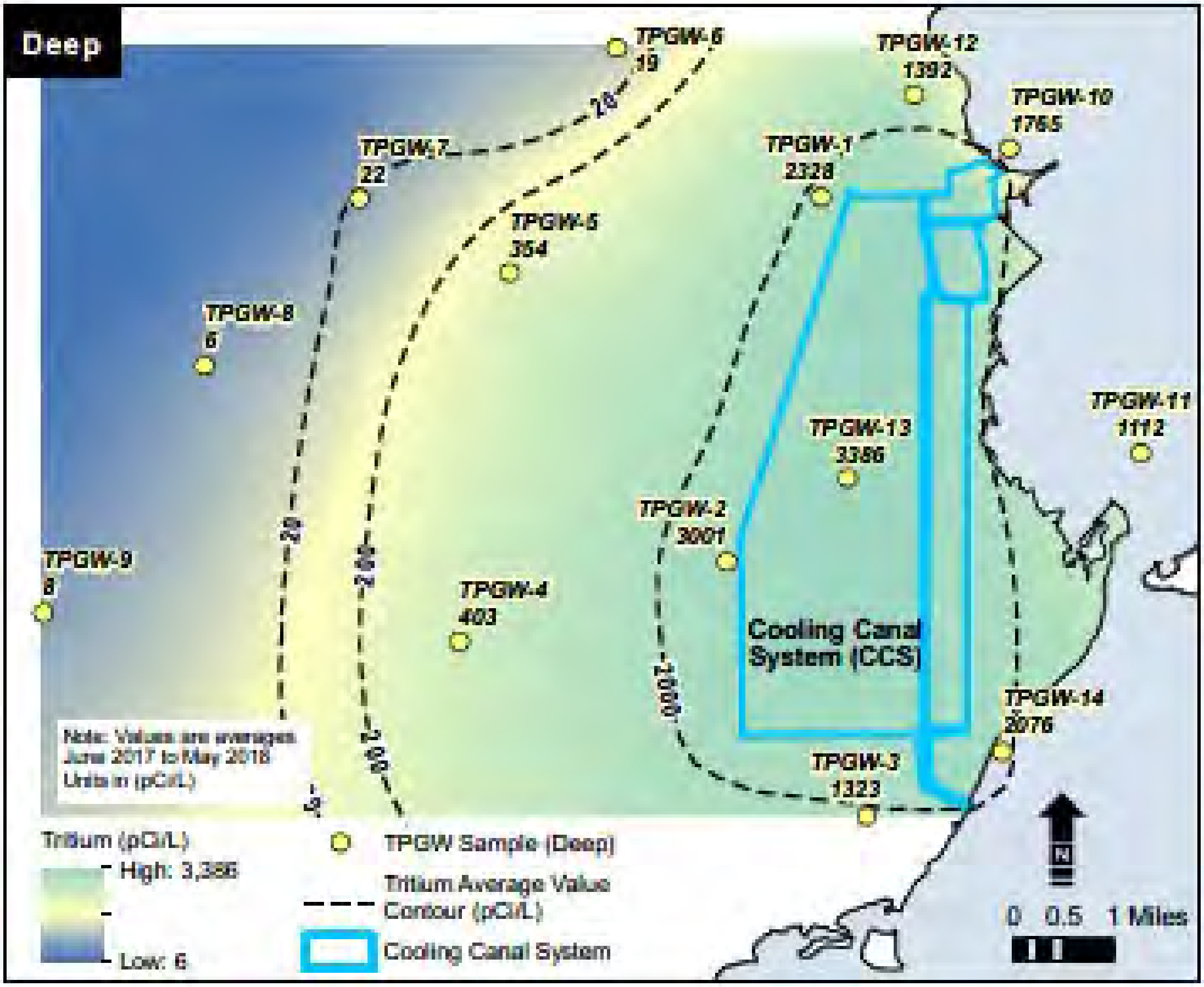


Source: Created from FPL 2019g

Figure 3-21b Time-Series Chart of Chloride Concentrations in Well Cluster TPGW-11, 2010-2018

In summary, the NRC staff concludes that hypersaline groundwater in the Biscayne aquifer presently exists under and adjacent to the CCS, with hypersaline conditions diminishing with increased distance from the CCS. As documented in FPL's latest (2018) annual monitoring report (FPL 2018o), the extent of "potential CCS influence" is 4.5 mi (7.2 km) west of the CCS as measured at the base (deep interval) of the Biscayne aquifer. This distance has not changed since 2017. Here, the composition of the groundwater includes ambient saline water mixed with small quantities of CCS water (including soluble salts, nutrients, and tritium), whereas the degree of CCS influence (marked by higher chloride and tritium concentrations) increases closer to the CCS (FPL 2018o). This line of influence is based on the latest available estimate of the 20 pCi/L concentration boundary for tritium in groundwater, with the mapped contour line passing just west of monitoring well TPGW-7D, which is depicted below in Figure 3-22. It should be noted that tritium readings of 20 pCi/L are not significant; for comparison, the EPA's primary drinking water standard or maximum contaminant level for tritium is 20,000 pCi/L (40 CFR 141.66).

For the March 2018 sampling event, the maximum observed tritium concentration in any well west of the CCS was 3,130 pCi/L at well TPGW-2M (Table 3-4). The extent of potential CCS influence based on tritium levels does not extend as far west in either the shallow or intermediate intervals of the Biscayne aquifer as it does in the deep interval of the aquifer. Elevated tritium levels in the intermediate and deep monitored portions of the aquifer also indicate the potential influence of CCS water in groundwater beneath Biscayne Bay, although effects do not extend as far east as they do to the west. For the March 2018 sampling event, the maximum tritium concentration in groundwater to the east of the CCS was 2,083 pCi/L at well TPGW-14D (Table 3-4).

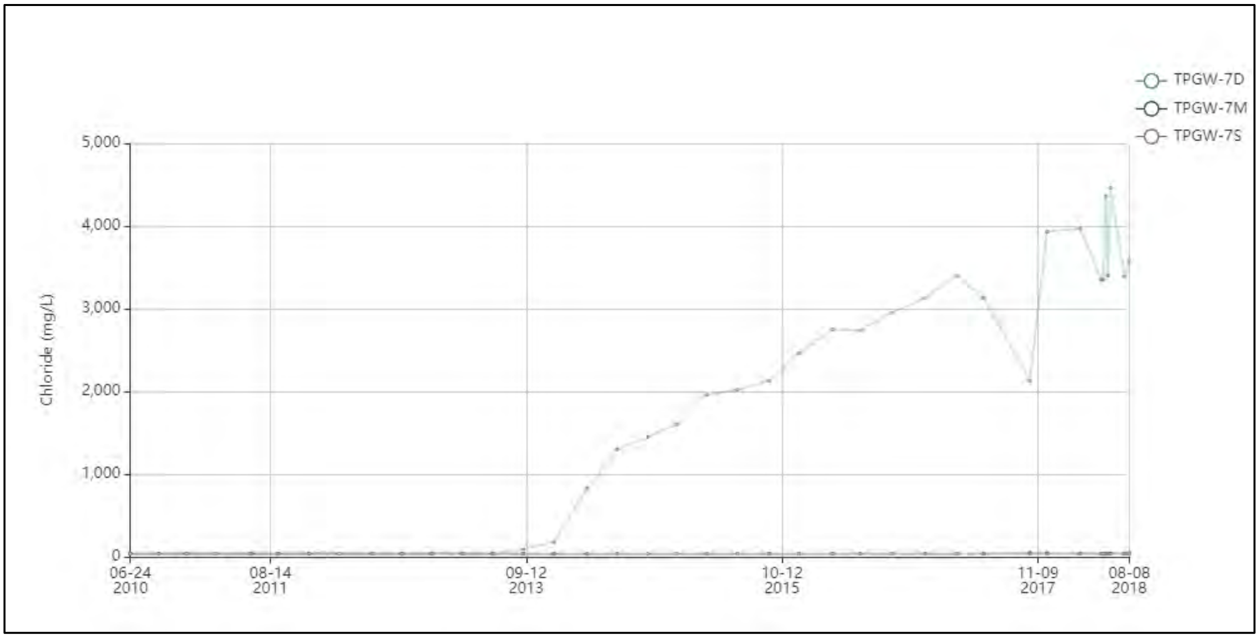


Source: Modified from FPL 20180: Fig. 3.4-4

Figure 3-22 Extent of Tritium in the Deep Interval of the Biscayne Aquifer, 2017-2018

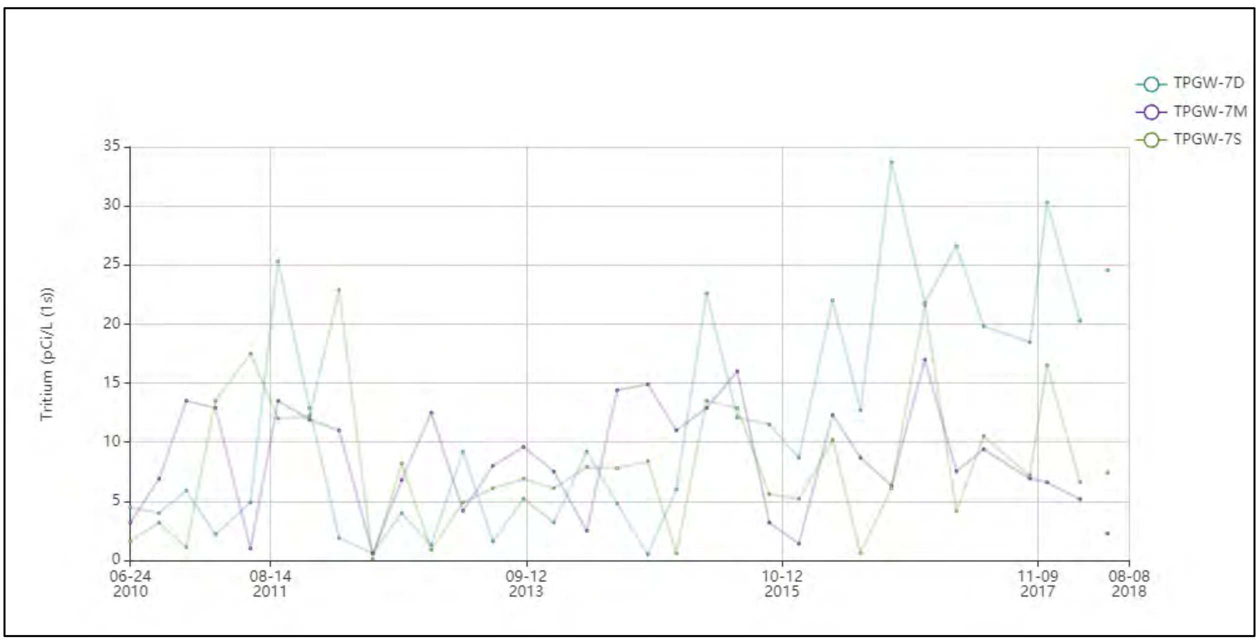
As described in FPL's annual monitoring reports, FPL had previously estimated the historical limit, prior to CCS construction, of Class G-III groundwater (non-potable water with a TDS content of 10,000 mg/L or greater). FPL based this estimate on historical TDS values from groundwater wells. Where historical TDS values were not directly available, FPL used the relationship between measurements of specific conductance and TDS to estimate historical TDS values. FPL's recent annual monitoring reports state that most of the Biscayne aquifer currently affected by the CCS never contained potable water (FPL 2017a, FPL 2018o).

Nevertheless, FPL's recent (2017 and 2018) annual monitoring reports state that monitoring has shown increases in one or more constituents (e.g., chloride, tritium) in several wells over the last 4 to 5 years that indicate the expansion of more saline groundwater, and possible CCS influence. These wells include TPGW-7D, TPGW-10D, and TPGW-11D. Figures 3-23a and 3-23b depict trends in chloride and tritium concentrations, respectively, in groundwater at well cluster TPGW-7. At TPGW-7D, the water transitioned from fresh water to brackish between the summer of 2013 and January 2017 (FPL 2017a), as illustrated in Figure 3-23a.



Source: Created from FPL 2019g

Figure 3-23a Time-Series Chart of Chloride Concentrations in Well Cluster TPGW-7, 2010-2018

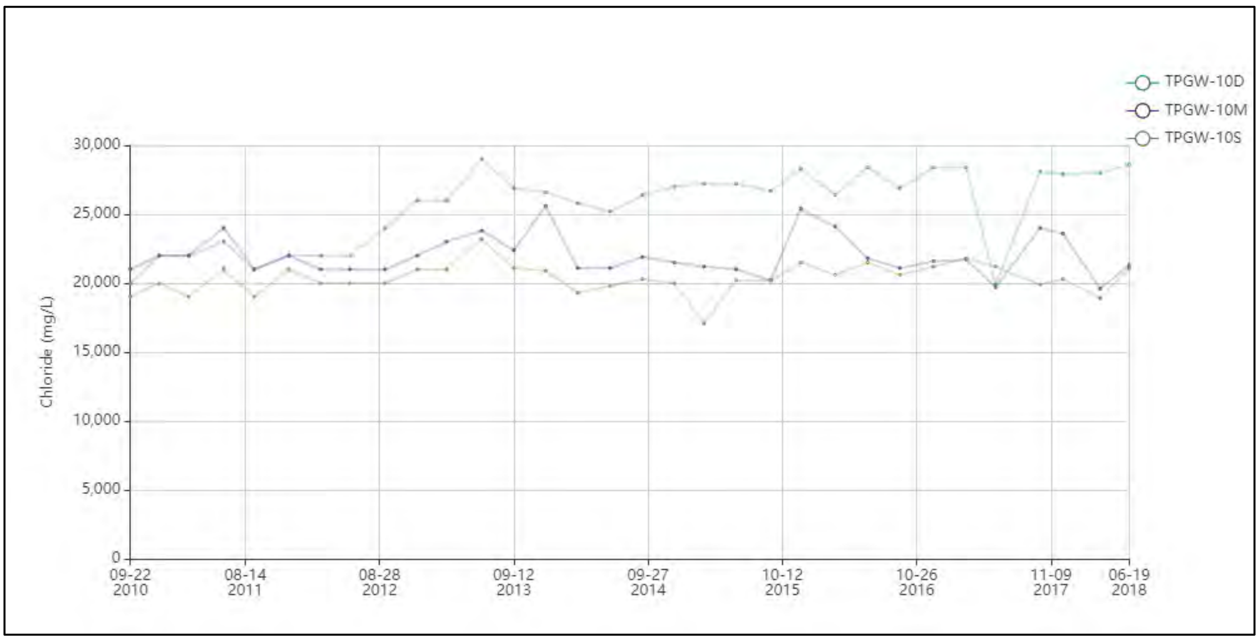


Source: Created from FPL 2019g

Figure 3-23b Time-Series Chart of Tritium Concentrations in Well Cluster TPGW-7, 2010-2018

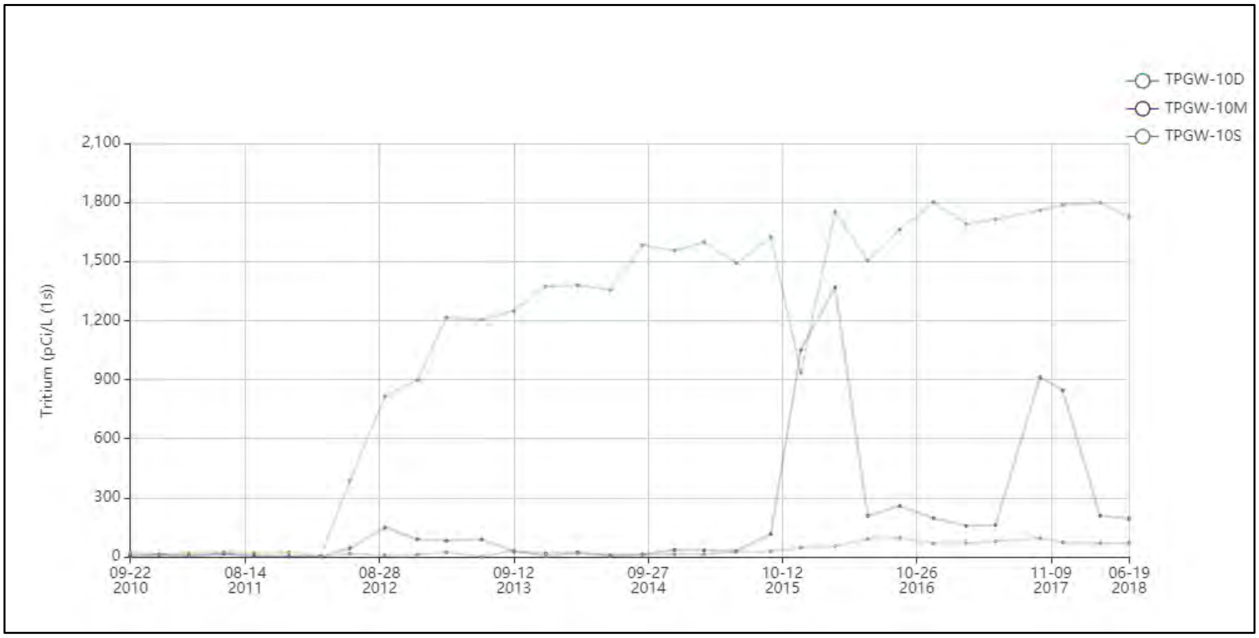
During the 2018 reporting period (June 1, 2017 through May 31, 2018), increases in conductance, chloride, and sodium continued at well TPGW-7D (FPL 2018o). FPL attributed the increase in observed ion concentrations (e.g., chloride) to the advance of the saltwater interface along the base of the Biscayne aquifer (FPL 2017a, FPL 2018o). In contrast, the average tritium value for the 2018 reporting period remained low (22.2 pCi/L). The report suggests that this may indicate that CCS water has little contribution to increases observed in saline groundwater at this well (FPL 2018o). While the NRC staff observes that tritium concentrations have remained relatively low (less than 35 pCi/L) and variable over the period 2010-2018, a slight increasing trend in tritium levels in the deep monitored interval (TPGW-7D) does appear to be evident, suggestive of possible CCS influence.

Meanwhile, wells TPGW-10D and TPGW-11D, just east of the CCS in Biscayne Bay, have exhibited increases in conductance, chloride, and tritium since 2012-2013 (FPL 2018o), as illustrated in Figures 3-24a and 3-24b for well cluster TPGW-10. FPL's 2017 annual monitoring report suggested that the increase in tritium in these wells was indicative of "a potential increase in the amount of CCS-sourced groundwater compared to the original marine groundwater" (FPL 2017a). Otherwise, FPL reports that monitoring data from FPL's monitoring network show that groundwater quality in most wells has exhibited little change overall since the inception of the monitoring program, and the data show that the well locations are generally insulated from normal daily and seasonal influences (FPL 2018o). In 2018, two wells exhibited short-term changes that FPL attributed to the effects of Hurricane Irma (September 2017). Saltwater constituents temporarily spiked at well TPGW-4S, and specific conductance and tritium spiked at TPGW-10M (discernible in Figure 3-24b) as exhibited in monitoring results immediately after the hurricane (FPL 2018o).



Source: Created from FPL 2019g

Figure 3-24a Time-Series Chart of Chloride Concentrations in Well Cluster TPGW-10, 2010-2018



Source: Created from FPL 2019g

Figure 3-24b Time-Series Chart of Tritium Concentrations in Well Cluster TPGW-10, 2010-2018

Current (2018) water quality monitoring results and other available well data continue to show that a fresher groundwater lens (i.e., low chloride and TDS concentrations) exists in the upper (i.e., 18 to 20 ft (5.5 to 6.1 m)) interval of the Biscayne aquifer just to the west of the CCS. This lens generally thickens to over 50 feet (15 m) in depth at TPGW-7 (see Figure 3-17). Here, in the shallow interval at this monitoring location (TPGW-7S), the groundwater appears to meet the Class G-II criterion for potable water use with a TDS content of less than 10,000 mg/L (see Table 3-4 and Figure 3-17). At a distance of over 5.5 mi (8.9 km) west of the CCS (e.g., at TPGW-9, see Table 3-4 and Figure 3-17), the aquifer is presently fresh at all depths (FPL 2017a, 2018o).

As referenced throughout this section by the NRC staff and described in FPL's annual monitoring reports, measurements of specific conductivity, salinity, and concentrations of chloride, tritium (as a tracer), and other water quality parameters can and have been used with varying degrees of difficulty to identify the potential influence of CCS water on ambient groundwater quality, as differing from natural saltwater. Consideration of the pathways for tritium transport can be problematic but is important for the purpose of source attribution (e.g., atmospheric deposition versus groundwater migration). Similarly, attribution of sources of nutrients (including ammonia, total nitrogen, and phosphorus) can be difficult and is further complicated by various processes that serve to attenuate their transport (FPL 2018o). Section 3.5.1.4, "Adjacent Surface Water Quality and Cooling Canal System Operation," of this SEIS describes potential sources of nutrients in the CCS and surrounding waters, including FPL's ongoing nutrient management efforts.

Table 3-5 summarizes groundwater monitoring results for nutrient concentrations in select wells in and around the CCS and compares the most recent (2018) monitoring results with the historical ranges in concentration for the nutrient.

Table 3-5 Summary of Groundwater Monitoring Results for Nutrients in Select Biscayne Aquifer Wells, Turkey Point Uprate Monitoring Program

Well Number (Location) and Monitoring Period	Monitored Interval	Ammonia (mg/L as Nitrogen)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
TPGW-1 (NW of CCS)	Shallow	0.38 to 1.29	1.12 to 1.91	0.004 to 0.046
Historical Range[(a)]	Intermediate	1.10 to 1.95	0.94 to 3.41	0.002 to 0.059
	Deep	1.30 to 2.04	1.24 to 2.78	0.08 to 0.057
	Shallow	1.35	2.24	0.035
March 2018[(b)]	Intermediate	1.75	**2.62**	0.037
	Deep	**1.84**	2.44	**0.040**
TPGW-2 (WSW of CCS)	Shallow	1.49 to 2.90	1.34 to 3.01	0.002 to 0.043
Historical Range[(a)]	Intermediate	1.50 to 2.74	1.90 to 3.34	0.013 to 0.082
	Deep	0.35 to 2.48	2.00 to 3.19	0.007 to 0.062
	Shallow	1.57	1.95	0.015
March 2018[(b)]	Intermediate	**3.14**	**3.13**	0.045
	Deep	2.68	2.77	**0.056**
TPGW-10 (NE offshore)	Shallow	0.32 to 0.92	0.31 to 1.10	0.002 to 0.085
Historical Range[(a)]	Intermediate	0.24 to 1.08	0.26 to 1.49	0.002 to 0.053
	Deep	0.22 to 1.45	0.33 to 1.83	0.004 to 0.051
	Shallow	0.43	0.85	0.017
March 2018[(b)]	Intermediate	0.47	0.91	0.023
	Deep	**1.38**	**1.68**	**0.056**
TPGW-13 (CCS)	Shallow	0.61 to 3.90	2.60 to 5.19	0.004 to 0.067
Historical Range	Intermediate	0.76 to 3.15	1.50 to 4.22	0.004 to 0.152
	Deep	0.06 to 3.66	1.70 to 5.43	0.002 to 0.077
	Shallow	**5.58**	**4.65**	0.047
March 2018[(b)]	Intermediate	3.40	3.38	0.069
	Deep	3.36	3.25	**0.064**
TPGW-14 (SE offshore)	Shallow	0.41 to 1.15	0.71 to 1.70	0.002 to 0.071
Historical Range[(a)]	Intermediate	0.66 to 1.55	1.05 to 1.91	0.003 to 0.074
	Deep	1.05 to 2.42	2.30 to 3.51	0.004 to 0.078
	Shallow	0.54	1.00	0.040
March 2018[(b)]	Intermediate	0.80	1.09	**0.062**
	Deep	**2.42**	**2.78**	0.060

Note: **Bold** used for emphasis to denote peak concentrations. NE=northeast; SE=southeast; WSW=west-southwest.

(a) Historical range reflects the minimum to maximum concentrations measured for each monitoring interval for each well over the period of record (June 2010 to March 2017).

(b) March 2018 quarterly sampling event (FPL 2018o).

Source: Compiled from FPL 2018o.

Based on the nutrient data presented, the NRC staff observes the following with respect to FPL's groundwater monitoring network. In 2018, and over the period of record (beginning in 2010) for the well clusters listed in Table 3-5, the highest concentrations of ammonia (an inorganic form of nitrogen), total nitrogen, and total phosphorus occur in groundwater beneath the CCS, as measured at well cluster TPGW-13 (located near the center of the CCS). Meanwhile, nutrient concentrations (e.g., total nitrogen and total phosphorus) in the waters of the CCS have generally been declining since about 2014, which can at least partly be attributed to FPL's freshening activities (see Section 3.5.1.4, "Adjacent Surface Water Quality and Cooling Canal System Operation"). The NRC staff's review of the data also reveals that there has been and continues to be substantial variability in measured nutrient concentrations at all monitoring well clusters, and at all depths, over the period of record. These considerations complicate attempts at correlating nutrient concentrations and other monitored parameters at groundwater monitoring locations with likely sources of the nutrients, thus giving rise to uncertainty in source attribution. Nonetheless, and as previously described in this section in relation to the groundwater monitoring results previously presented in Table 3-4, concentrations of particular water quality parameters (i.e., chloride and tritium) tend to increase with depth in the Biscayne aquifer due to the greater density of saline water. Thus, the presence of these constituents together at elevated concentrations in the intermediate and deep intervals of the aquifer can be helpful in revealing the density-driven movement and influence of CCS water through the aquifer.

For the select Biscayne aquifer well clusters immediately surrounding the CCS, the monitoring data presented in Table 3-5 reveal that nutrient levels generally increase in concentration with depth. This observation generally holds for the most recent, published monitoring results as well as for results over the period of record (2010-2018). The exception is in well cluster TPGW-13 that monitors groundwater immediately beneath the CCS, where the concentrations of ammonia and total nitrogen were highest in the shallow interval of the aquifer during the March 2018 quarterly sampling event.

Based on the March 2018, monitoring results (Table 3-5), the highest nutrient concentrations occur in the intermediate and deep intervals of the aquifer in both the well clusters immediately to the west of the CCS (TPGW-1, TPGW-2) as well as in those to the east and offshore in Biscayne Bay and Card Sound, well clusters TPGW-10 and TPGW-14, respectively. The highest chloride and tritium concentrations at these locations occur in the intermediate and deep intervals of these four wells, as shown in the expanded groundwater monitoring data summarized in Table 3-4. The highest tritium concentrations in these four wells (TPGW-1, TPGW-2, TPGW-10, and TPGW-14) are 2,307, 3,130, 1,798, and 2,083 pCi/L, respectively, as compared to a maximum of 6,016 pCi/L in TPGW-13 beneath the CCS. Additionally, the monitoring results (Table 3-4) for the four well clusters, as for TPGW-13, indicate hypersaline conditions (chloride concentrations greater than 19,000 mg/L) in the intermediate and deep intervals of the Biscayne aquifer. As previously discussed for chloride and tritium in these wells, the elevated nutrient concentrations further suggest the influence of CCS water in the intermediate and deep monitored intervals of the Biscayne aquifer at these monitoring locations.

<u>Regulatory Developments with Respect to Cooling Canal System Operations and Groundwater Quality</u>

As discussed above, beginning in 2010, FPL implemented an expanded groundwater monitoring program in support of Turkey Point's extended power uprate and associated regulatory approvals. This expanded groundwater monitoring program helped to identify the need for FPL to take corrective actions to address onsite and offsite impacts associated with operation of the CCS, especially involving salinity, chloride, and ammonia concentrations (FPL 2018f). In consultation with and at the direction of State and local regulatory agencies (i.e., Miami-Dade County DERM), since 2013, FPL has undertaken a number of actions to mitigate impacts associated with CCS operation. Most of these actions focus on reducing high salinities within the CCS. Most recently, these actions have included active measures to halt and remediate the migration of the hypersaline plume from the CCS. This section of the SEIS presents a brief summary of the history, the current status, and the scope of the associated regulatory mechanisms governing FPL's actions focusing on groundwater quality issues.

In December 2014, the FDEP issued an administrative order to FPL directing, in part, that FPL develop a salinity management plan for the CCS along with additional monitoring requirements (FDEP 2014, FPL 2018f). Several entities, including Miami-Dade County, challenged the FDEP's 2014 administrative order.

On October 2, 2015, Miami-Dade County issued a notice of violation (NOV) to FPL alleging violations of county water quality standards and criteria in groundwater beyond the boundaries of the CCS and FPL property (FPL 2018f, MDC 2015a). Subsequently, on October 7, 2015, Miami-Dade County and FPL entered into a Consent Agreement (the 2015 Consent Agreement). In the 2015 Consent Agreement, the County recognized the salinity reduction efforts that FPL was already undertaking including the use of onsite marine production wells and plans to construct six wells to withdraw water from the Upper Floridan aquifer for CCS salinity reduction. The 2015 Consent Agreement requires FPL to evaluate alternative water sources to offset water deficits in the CCS and to reduce chloride concentration in the CCS, including the use of reclaimed wastewater from the Miami-Dade South District Wastewater Treatment Plant (FPL 2018f, MDC 2015a). Moreover, the 2015 Consent Agreement specifically requires FPL to maintain measures to abate hypersaline water discharges and to actively remediate the hypersaline groundwater west and north of FPL's property, without creating adverse environmental impacts. The stipulated remedial action is the installation and operation of a Biscayne aquifer recovery well system to intercept, capture, and retract the hypersaline plume from the CCS to within FPL's property boundary, along with associated deep well disposal of the extracted hypersaline groundwater. The Consent Agreement also requires that FPL conduct additional groundwater monitoring, submit annual reports and undertake surveys (i.e., continuous surface electromagnetic mapping of the hypersaline plume) to gauge progress toward meeting the terms of the agreement. The latest available mapping results are described above (see "Baseline Groundwater Quality and Changes Attributable to Turkey Point Operations"). Finally, FPL is required to review, report, and consult on any necessary changes related to the effectiveness of the recovery well system at 5-year and 10-year intervals (MDC 2015a).

On August 15, 2016, FPL and Miami-Dade County executed an addendum revising the 2015 Consent Agreement. The revised agreement (the 2016 Addendum) requires FPL to take action to evaluate and address alleged violations of Miami-Dade County water quality standards and cleanup target levels relating to the exceedance of ammonia standards in surface water, including deep remnant canals adjacent to the Turkey Point CCS. The 2016 Addendum further requires that FPL prepare a site assessment report to identify the sources of ammonia exceedances and to delineate their extent in surface water in accordance with a site assessment plan approved by Miami-Dade County (MDC 2016a). On December 29, 2016, in response to the County's comments on the draft site assessment plan, FPL submitted an amended site assessment plan, and it initiated environmental sampling on January 3, 2017, as approved by Miami-Dade County (FPL 2017b). FPL submitted its completed site assessment report to the County on March 17, 2017 (FPL 2017c, FPL 2018p).

The completed ammonia site assessment report documents the results of FPL's sampling and analysis program to assess the nature and extent of ammonia in surface waters near the Turkey Point site and in the CCS. It includes sampling results from numerous surface water, porewater, canal water, and groundwater sampling locations as well as stratified surface water sampling. With respect to groundwater, FPL sampled nine monitoring wells completed in the Biscayne aquifer, including: (1) four wells northeast of the Turkey Point power block (FTF-SW, FTF-NW, FTF-SE, MW-5), (2) two wells east of the power block (MW-3, MW-4) adjacent to the discharge canal and Biscayne Bay, (3) two wells (South MW, North MW) southeast of the power block near FPL's sanitary injection well and discharge canal, and (4) one deeper well located south of the Turkey Point complex in the mud flat area known as Mud Island (C6-5). While all wells had detectable ammonia, the concentrations were variable, ranging from a low of 0.17 mg/L at MW-3 adjacent to the intake canal and Biscayne Bay to a high of 4.6 mg/L at the South MW, as compared to the Miami-Dade County water quality standard of 0.5 mg/L. The report states that the high concentration of ammonia at South MW and relatively fresh water in the well may be caused by the sanitary wastewater injection well. Well C6-5 had the second highest ammonia concentration (2.48 mg/L). This deeper well (C6-5) at 90 feet (27 m) was the only well sampled that also exhibited hypersalinity (52.2 PSU), indicating potential CCS influence (FPL 2017c).

In July 2017, Miami-Dade County requested that FPL collect additional data in support of the ammonia site assessment report (FPL 2017b). In November 2017, FPL responded to the County's request by submitting supplemental information (FPL 2017h). In a July 10, 2018 letter, the Miami-Dade County DERM informed FPL that it had completed its review of the site assessment report and supplemental information. The County's letter states that based on its review of FPL's ammonia data as well as its review of historical groundwater monitoring data collected from the TP-GW series uprate monitoring wells (e.g., TPGW-1, TPGW-2, TPGW-10, TPGW-13, and TPGW-14), there is a "statistically significant increasing trend" in ammonia concentrations in groundwater in the intermediate and deep intervals along with a concentration gradient emanating from the CCS. The County's letter directs FPL to undertake a number of additional actions, including development of a revised sampling plan for ammonia in surface water and groundwater and measures to reduce nutrient impacts from the CCS on surface waters and groundwater (MDC 2018a). FPL responded to the County's comments with a letter report in October 2018 (FPL 2018r). FPL stated, in part, that the ammonia concentrations in groundwater surrounding the CCS fall below the County's cleanup target levels specified in Section 24-44(2)(f)(v) of the County Code (FPL 2018r; MDC 2019c). For ammonia in groundwater, the County cleanup target level is 2,800 ug/L (equivalent to 2.8 mg/L) (MDC 2019c). FPL also reiterated its ongoing activities to implement nutrient management practices consistent with its approved Nutrient Management Plan (FPL 2018r). Surface water sampling results from the ammonia site assessment report, associated findings regarding source attribution, FPL's ongoing nutrient management efforts, and followup actions are discussed in Section 3.5.1.4, "Adjacent Surface Water Quality and Cooling Canal System Operation," of this SEIS.

Separately, the FDEP issued a modified final administrative order to FPL on April 21, 2016 (the 2016 Final Administrative Order) (FDEP 2016h, FPL 2018f). The FDEP's 2016 Final Administrative Order concludes, in part, that "the preponderance of the record evidence indicates the CCS is the major contributing cause of the continuing westward movement of the saline water interface" (FDEP 2016h).

As discussed in Section 3.5.1.4 above (regarding "Ammonia and Nutrients within Biscayne Bay and Card Sound") on April 25, 2016, the FDEP issued a warning letter (FDEP 2016c) expressing concern that CCS water was reaching Biscayne Bay. FPL responded by submitting nutrient monitoring data on May 16, 2016, to the FDEP for its review (see Section 3.5.1.4, "Adjacent Surface Water Quality and Cooling Canal System Operation." Concurrently, the

FDEP issued a notice of violation to FPL that incorporated findings from the FDEP's April 21, 2016 Final Administrative Order and specifically directed FPL to enter into consultations to develop a Consent Order for corrective actions to abate the CCS contribution to the hypersaline plume, reduce the size of the hypersaline plume, and prevent future harm to waters of the State (FDEP 2016d, FPL 2018f).

To resolve the warning letter and notice of violation, FPL and the FDEP executed a Consent Order on June 20, 2016 (the "2016 FDEP Consent Order") (FDEP 2016a). The 2016 FDEP Consent Order contains three primary objectives (FDEP 2016a; FPL 2018f) as well as the methods FPL must use to meet each objective. The three objectives are as follows (FDEP 2016a).

- First Objective. Cease discharges from the CCS that impair the reasonable and beneficial use of the adjacent Class G-II groundwater by maintaining the average annual salinity of the CCS at or below 34 PSU, by undertaking freshening activities, by eliminating the CCS contribution to the hypersaline plume, by halting the westward migration of hypersaline water from the CCS, and by reducing the westward extent of the hypersaline plume to the L-31E Canal within 10 years, thereby removing its influence on the saltwater interface without creating adverse environmental impacts.
- Second Objective. Prevent releases of groundwater from the CCS to surface waters connected to Biscayne Bay that result in exceedances of surface water quality standards in Biscayne Bay.
- Third Objective. Provide mitigation for impacts related to the historic operation of the CCS, including but not limited to the hypersaline plume and its influence on the saltwater interface.

The First Objective of the 2016 FDEP Consent Order primarily involves reducing salinity in the CCS and thereby also reducing the CCS contribution to the hypersaline plume in the Biscayne Aquifer and the plume's westward migration. Since 2015, FPL has been using a variety of water sources to manage salinity within the CCS. It has also implemented several additional CCS operational and surface water quality management measures as required by the 2016 FDEP Consent Order, which are discussed in Section 3.5.1.4, "Adjacent Surface Water Quality and Cooling Canal System Operation," of this SEIS.

With regard to meeting the 34 PSU salinity metric specified in the 2016 FDEP Consent Order and consistent with the requirements of the 2015 Consent Agreement with Miami-Dade County, FPL commenced operation of a new freshening well system on November 28, 2016, adding groundwater from the Upper Floridan aquifer to the CCS. The State of Florida authorizes FPL to withdraw up to 14 mgd (53,000 m^3/day) from the Upper Floridan aquifer from six wells under its modified site certification for the Turkey Point site (FDEP 2016b, State of Florida Siting Board 2016). FPL has constructed five wells to date (i.e., wells F-1, F-3, F-4, F-5, and F-6). By adding relatively brackish (i.e., average of 2.5 PSU) Upper Floridan aquifer groundwater to the CCS, FPL intends to minimize the increase in salinity that can occur in the CCS during the yearly dry season, reduce average CCS salinity to meet the 2016 FDEP Consent Order metric of 34 PSU, and reduce the CCS contribution to the existing hypersaline plume (FPL 2018f). Section 3.5.2.3, "Groundwater Use," in this SEIS contains a separate discussion of groundwater withdrawals associated with salinity reduction and other activities at the Turkey Point site.

In order to stop and then retract the westward migration of hypersaline groundwater originating from the CCS, the 2016 FDEP Consent Order requires FPL to permit, construct, and operate a recovery well system to remediate the hypersaline plume in the Biscayne aquifer (FDEP 2016a). This requirement is consistent with the 2015 Consent Agreement (MDC 2015a) between FPL and Miami-Dade County, as described previously. Additionally, the Consent Order stipulated enhancements to FPL's groundwater monitoring network by requiring the addition of new well clusters and additional monitoring data reporting (FDEP 2016a).

From September 2016 until mid-2018, FPL conducted hypersaline extraction and deep well injection testing, which had the benefit of initiating salt removal from the Biscayne aquifer. In 2013, FPL had sought and obtained permission from FDEP to permit Deep Injection Well DIW-1 as a Class I injection well by converting the existing Class V exploratory well (EW-1), originally installed for the proposed new reactors, Turkey Point Units 6 and 7 (FDEP 2013). FPL used the existing deep injection well (DIW-1) and four, 90-feet (27-m) deep Biscayne aquifer production wells constructed by FPL in the CCS for assessing flow rates for the recovery wells. The test production/extraction wells were operated from September 28, 2016, to May 7, 2018 (FPL 2017a, FPL 2018f, FPL 2018o). By letter dated June 21, 2016, FDEP authorized FPL to carry out the testing program in accordance with underground injection control Permit 293962-002-UC and Permit Modification 293962-003-UC/MM (FDEP 2013, FDEP 2016f, FDEP 2016g).

Meanwhile, in May 2017, Miami-Dade County approved FPL's remedial action plan for design and construction of the recovery well system (MDC 2017e). FPL began construction of the full-scale hypersaline groundwater recovery well system on June 19, 2017 (FPL 2017a). The recovery well system was completed on May 15, 2018, and it then became operational (FPL 2018h). Operation of the extraction well portion of the system is authorized under a SFWMD water use permit (Permit No. 13-06251-W), issued to FPL in February 2017 (SFWMD 2017a).In July 2018, FDEP issued underground injection control Permit No. 0293962-004-UO/1I to FPL for operation of deep injection well DIW-1 for disposal of hypersaline groundwater (FDEP 2018d).

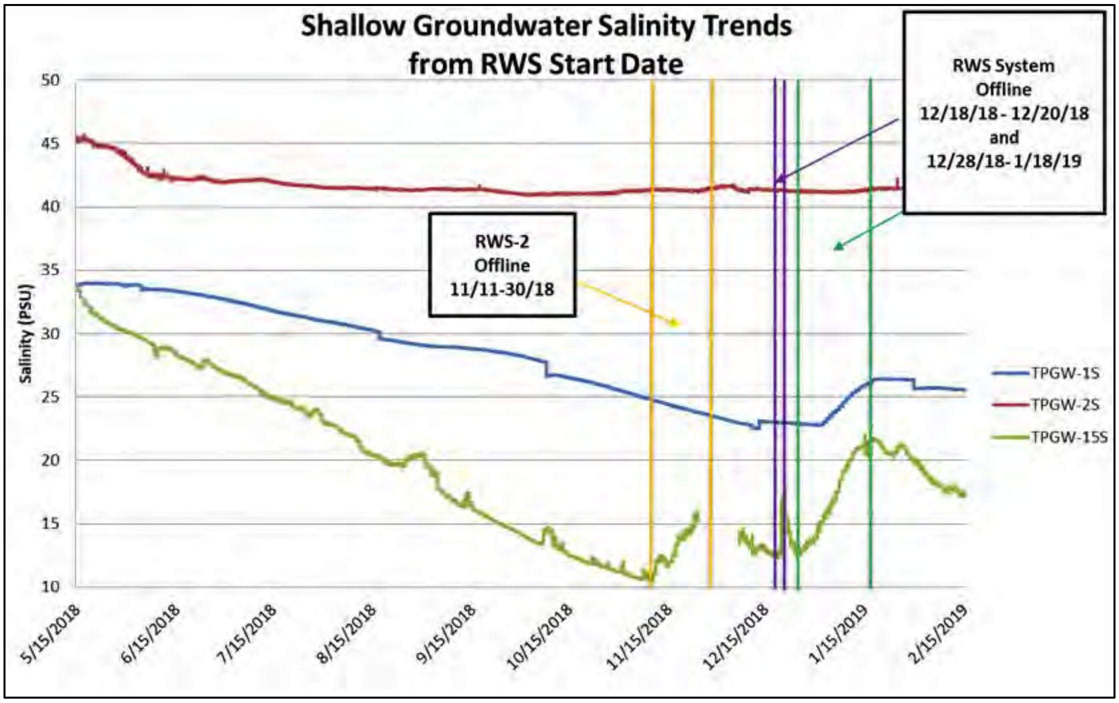
The installed full-scale hypersaline groundwater recovery well system consists of 10 hypersaline groundwater recovery (extraction) wells (i.e., numbered RW-1 through RW-10), generally located along the western edge of the CCS, and the Class 1 deep injection well (DIW-1) for disposal of the recovered hypersaline groundwater (Figure 3-25). Between October 2016 and September 2018, the testing and recovery well systems have extracted and disposed of approximately 9,564 million gallons (36.2 million m^3) of hypersaline groundwater, with the removal of 2.27 million tons (2.06 million metric tons) of salt from the Biscayne aquifer (FPL 2017b, 2018p). FPL further estimates that recovery well operations have had the added benefit of removing more than 27,600 lbs (12,500 kg) of ammonia (a nutrient of concern) from the aquifer (FPL 2018r). Section 3.5.2.3, "Groundwater Use," provides additional details on the recovery well system.

The latest available recovery well system status reports show that the system is reducing salinities in the shallow (upper) interval of the Biscayne aquifer adjacent to the recovery wells. Groundwater monitoring data indicate an overall declining trend in salinity in the shallow wells adjacent to the CCS (including wells TPGW-1S, TPGW-2S, and TPGW-15S), with no significant change observed in the intermediate (middle) or deep zones. This trend is evident in Figure 3-26.

In its environmental report, FPL stated that groundwater modeling of the recovery well system operation indicates that the westward migration of the hypersaline plume will be stopped in 3 years of operation, with retraction of the hypersaline plume north and west of the CCS beginning in 5 years. FPL further projects that system operation will achieve retraction of the plume back to the FPL site boundary within 10 years, as required by the 2016 FDEP Consent Order with FDEP (FPL 2018f). FPL is required to conduct periodic continuous surface electromagnetic mapping surveys to delineate the extent of the hypersaline plume in order to measure the success of recovery and remediation efforts and report the results to FDEP.

Source: Modified from FPL 2018q

Figure 3-25 Layout of Biscayne Aquifer Recovery Well System and Injection Wells



Source: Modified from FPL 2019i

Figure 3-26 Salinity Trends in Groundwater Monitoring Wells Near the CCS in Response to Recover Well System Operations

After 5 years of system operation, FPL must provide a report to FDEP that evaluates the effectiveness of the recovery well system in retracting the hypersaline plume to the L-31E Canal within 10 years. If FPL's report shows that the remediation efforts will not retract the hypersaline plume to the L-31E Canal within 10 years, FPL must develop and submit an alternate plan to FDEP for its approval (FDEP 2016a).

The Second Objective of the 2016 FDEP Consent Order focuses on the prevention of releases of groundwater from the CCS to surface waters connected to Biscayne Bay. To address these impacts, the 2016 FDEP Consent Order requires FPL to undertake specific environmental restoration projects at Turtle Point and at the Barge Turning Basin, as well as implement a Nutrient Management Plan for the CCS, and to complete and report on the results of an inspection of the periphery of the CCS (FDEP 2016a). For status summaries of these projects, see the discussion in Section 3.5.1.4, "Adjacent Surface Water Quality and Cooling Canal System Operation," of this SEIS.

The Third Objective of the 2016 FDEP Consent Order requires mitigation for impacts related to the historic operation of the CCS, including but not limited to the hypersaline plume and its influence on the saltwater interface. Discrete mitigative actions specified in the 2016 FDEP Consent Order require FPL to convey specified tracks of FPL property to the SFWMD, if so requested, to facilitate the Comprehensive Everglades Restoration Plan; to make financial contributions to the State of Florida to support mitigation for saltwater intrusion; and to conduct water quality sampling in order to improve trend analysis in Biscayne Bay and Card Sound surface waters. Moreover, the 2016 FDEP Consent Order requires FPL to complete an analysis using the variable density, three-dimensional groundwater model developed in accordance with the requirements of the 2015 Consent Agreement to "allocate relative contributions of other entities or factors to the movement of the saltwater interface" (FDEP 2016a).

In June 2018, FPL presented the results of its modeling analysis to FDEP staff. In summary, FPL commissioned Tetra Tech, a consulting and engineering services company, to conduct an attribution sensitivity analysis using its existing variable density flow and salinity transport model (Tetra Tech 2018). Modeling runs were conducted to evaluate eight regional and environmental factors as compared to a base scenario in order to assess the effects of these factors on the location of the saltwater interface. These factors included: (1) operation of the Turkey Point CCS, (2) sea level rise, (3) changes in land use, (4) decadal-scale changes in climate in terms of precipitation recharge, (5) construction of drainage structures and changes to drainage practices, (6) construction and operation of controlled freshwater canals, (7) changes to groundwater use (changes to the operation and capacity of nearby wellfields), and (8) management and operation of mining practices west of the CCS.

A number of regional and localized human-induced factors have contributed to the migration of the saltwater interface over time (see Sections 3.5.1.1 and 3.5.2.1). FPL's modeling analysis indicates that operating the CCS with salinity in excess of 35 PSU is currently the single largest contributor to changes (movement) in the location of the saltwater interface, as measured by the areal extent of the saltwater interface. Changes were measured based on the average change in the area of salinity greater than 0.05 PSU west of the CCS over the thickness of the Biscayne aquifer. More specifically, the modeling indicates that approximately 46 percent of the change in areal extent of the saltwater interface is attributable to hypersaline conditions in the CCS. Other than CCS hypersalinity, the modeling indicates that the next-most-influential locational factors are changes in climate (23 percent), followed by the construction and operation of controlled freshwater canals over the last 50 to 60 years (14 percent) (Tetra Tech 2018).

<u>Routine and Potential Inadvertent Releases of Radionuclides and Other Pollutants to Groundwater</u>

Nuclear power plants and other industrial facilities can impact groundwater quality by inadvertent releases of chemicals and petroleum products. Nuclear power plants can also impact groundwater quality through inadvertent releases of radionuclides, predominantly tritium, from spills and leaks from plant systems (NRC 2013a).

Nuclear power plants routinely release dilute concentrations of radionuclides, including tritium, in effluents (liquid and gaseous wastes) subject to compliance with NRC regulations. These authorized releases are closely monitored by the plant operator and reported to the NRC, with reports made available to the public on the NRC's Web site, in the form of annual radioactive effluent release reports. Similarly, potential impacts to the public and to the environment from plant radiological releases are evaluated and reported by NRC licensees in radiological environmental operating reports, which are also publicly available. Routine radiological effluents from Turkey Point Units 3 and 4, and FPL's associated effluent management and radiological environmental monitoring programs are described in Section 3.1.4.1, "Radioactive Liquid Waste Management," Section 3.1.4.2, "Radioactive Gaseous Waste Management," and Section 3.1.4.5, "Radiological Environmental Monitoring Program," of this SEIS.

Normal operation of Turkey Point Units 3 and 4 results in the release to the CCS of monitored and permitted effluents containing tritium. Evaporation of CCS water results in tritium being released to the atmosphere as a component of the water vapor, while radioactive decay (with a half-life of approximately 12 years) limits the buildup of tritium concentrations over time in the waters of the CCS (NRC 2016a).

In 2018, based on the results of FPL's radiological environmental monitoring, the average tritium concentration in the waters of the CCS was 7,434 pCi/L, with a maximum level of 21,851 pCi/L in November 2018 at site T08 (on the southern shore of the CCS, west of Grand Canal Bridge) (FPL 2019c). Of the four supplemental surface water stations in FPL's REMP, the NRC staff assumes that this sampling location may be generally representative of ambient tritium levels in the CCS. For 2017, the average tritium concentration in the CCS was 10,391 pCi/L, with a maximum level of 24,483pCi/L at site T08 in March 2017 (FPL 2018k). For comparison, the EPA's primary drinking water standard for tritium is 20,000 pCi/L (40 CFR 141.66). Section 3.5.1.4, "Adjacent Surface Water Quality and Cooling Canal System Operation," further describes surface water quality in the CCS. As discussed there and as shown in Figure 3-22, "Extent of Tritium in the Deep Interval of the Biscayne Aquifer in the Vicinity of the Turkey Point Site, 2017–2018," tritium concentrations decrease significantly with increasing distance from the site, with levels substantially below the EPA's primary drinking water standard.

Because the canals comprising the CCS are not lined, CCS water, which contains tritium, migrates into the groundwater of the underlying Biscayne aquifer (FPL 2018f, NRC 2016a). Within the highly permeable aquifer, diffusion is rapid and groundwater flow is relatively fast (FPL 2016h). Thus, tritium occurs in underlying groundwater in the Biscayne aquifer beneath the CCS as well as in adjacent areas of the aquifer that are beneath the Turkey Point, Units 3 and 4 plant complex.

An additional consideration for the presence and transport of tritium is that engineered backfill (crushed, compacted limestone) was used around the Turkey Point plant complex (nuclear island) with some structures extending to a depth of 45 feet (14 m) below land surface. On a more localized basis, subsurface structures may alter or impede the direction of groundwater flow (FPL 2016h). Further, it is likely that subsurface structures and the engineered backfill itself offer a preferential flow path for water containing tritium to reach the Biscayne aquifer beneath portions of the Turkey Point plant complex. Any inadvertent releases of liquids containing radioactive constituents from plant facilities and systems, spills, or leaks can also migrate to underlying groundwater.

Potentiometric surface (water table elevation) maps developed for the Turkey Point site and reviewed by the NRC staff show that groundwater flow across the main plant complex is tidally influenced in the shallow, intermediate, and deep monitored portions of the Biscayne aquifer. FPL states in its "Updated Final Safety Analysis Report, Turkey Point Units 3 & 4," that there is a rather consistent tidal influence on groundwater elevations across the Turkey Point site of 0.2 to 0.5 ft (0.06 to 0.15 m) maximum tidal fluctuation (FPL 2016h). Groundwater flow paths are further influenced by plant operations where operation of the circulating water system and associated intake and discharge canals generally produces radial flow across the plant site at shallow and intermediate depths during most tidal regimes. This appears to generally occur due to groundwater mounding on the discharge canal (west) side of the plant complex and a depressed water table surface on the intake (east side) of the plant. In contrast, during both low and high tides, groundwater flow in the deep portion of the Biscayne aquifer is more unidirectional, from south to north and from east to west (FPL 2018f).

FPL participates in the NEI 07-07, "Industry Ground Water Protection Initiative" (NEI 2007). The initiative identifies actions to improve management and response to instances in which the inadvertent (i.e., unplanned, uncontrolled, and unmonitored) release of radioactive substances may result in low but detectible levels of nuclear power plant-related radioactive materials in subsurface soils and water. The initiative identifies those actions necessary for the implementation of a timely and effective groundwater protection program along with acceptance criteria to demonstrate that the objectives have been met.

Since 2010, FPL has maintained a radiological environmental sampling and analysis program for Turkey Point that meets the recommendations of NEI 07-07. FPL performs groundwater monitoring at 28 onsite locations around Turkey Point Units 3 and 4 for potential inadvertent radioactive releases through groundwater pathways at the Turkey Point site in accordance with site procedures. FPL collects samples on at least a quarterly basis or more frequently if deemed necessary (FPL 2018f). Some of the groundwater monitoring locations have multiple (two or three) depths.

FPL states in its environmental report that it has detected tritium (a beta-emitting radioactive isotope of hydrogen) in groundwater. Since establishing its NEI 07-07 program, FPL has detected no Turkey Point-related gamma-emitting isotopes (FPL 2018f).

The NRC staff reviewed FPL's annual effluent release and radiological environmental operating reports for a 5-year period (2014 through 2018). The NRC staff found that FPL has documented seven actual or potential inadvertent releases to groundwater from Turkey Point, Units 3 and 4 operations. FPL completed appropriate corrective actions and entered the events and actions taken in the plant corrective action program, as appropriate. The list below summarizes these unplanned liquid releases:

- March 19, 2014, the Turkey Point Unit 3E demineralizer fill valve leaked a small amount of reactor coolant system (RCS) water (i.e., about 1 gallon (3.8 L)) on the roof of the auxiliary building, which was promptly cleaned up.
- August 24, 2014, the Turkey Point Unit 4 refueling water storage tank (RWST) purification pump (4P209) drain line leaked 5 gallons (19 L) of reactor coolant system water to the ground. Corrective actions included increasing sampling of Turkey Point monitoring wells (i.e., PTN-MW-8S, PTN-MW-9S, and P-94-4) for gamma and tritium activity.
- September 23, 2014, the Unit 4 demineralizer resin fill valve and flange located on the roof of Turkey Point Unit 4 auxiliary building leaked about 50 gallons (190 L) of reactor coolant system water. Rainfall caused the leak to migrate to the storm drain system. Contamination included 0.132 Ci of cobalt-58 and 0.019 Ci of tritium. Corrective actions included monitoring the southeast storm drain as well as nearby monitoring wells (i.e., PTN-MW-8S and PTN-MW-9S).
- October 14, 2014, the Turkey Point Unit 4 RWST valve 4-804 B leaked during the transfer of water from the refueling cavity. Approximately 1 L of reactor coolant system water was released to the ground before the leak was stopped. Corrective actions included monitoring nearby wells (i.e., PTN-MW-8S, PTN-MW-9S, and P-94-4) monthly for gamma activity and tritium.
- November 11, 2014, a pump casing leak occurred from the 4P209 Unit 4 RWST purification pump. The total leak volume was not estimated but the pump leak was estimated to be approximately 60 drops per minute until the pump was shut down upon

discovery of the leak. Corrective actions included increasing sampling of wells in the vicinity (i.e., PTN-MW-8S, PTN-MW-9S, and P-94-4) to monthly for gamma activity and tritium.

- July 26–September 15, 2015, a leak of intake cooling water contaminated with sodium-24 from the Turkey Point Unit 3 component cooling water (CCW) system occurred. Chemical inhibitors that contain sodium become activated when the CCW travels into a neutron field. The Turkey Point Unit 3 CCW heat exchanger, cooled by intake cooling water, developed a leak, and CCW, which contained activated sodium, leaked into the tube side of the heat exchanger. The release continued until the heat exchanger was plugged. The intake cooling water discharges into the mixing basin on the western side of plant, which is the same area used as discharge for the regular liquid radwaste tanks. The total release volume was approximately 4,828 gal (18,280 L). The total estimated quantity of sodium-24 released was 6.19 micro-Curies.
- October 5, 2017, the Unit 4D demineralizer resin fill valve and flange located on the roof of the Unit 4 auxiliary building showed signs of leakage to the roof. The southeast storm drain (in the likely flow path) was sampled and showed activity. The calculated dose from the estimated activity released was determined to be well below site Offsite Dose Calculation Manual limits.
- January 21, 2018, a spill occurred on the roof of the auxiliary building when radiation workers removed the protective cover on the Unit 4D demineralizer resin fill isolation valve. The spill volume was about 0.5 gal (1.9 L) and reached the storm drain system after initial response efforts were ineffective. Corrective actions included a complete replacement of the demineralizer rubber diaphragm valve with a new ball valve with stainless steel internals in order to eliminate valve leakage. The frequency of sampling of the surrounding monitoring wells (e.g., PTN-MW-8S) was increased to weekly, and no significant impact to groundwater was observed following the release.
- On August 8, 2018, weepage was identified from two RWST locations on the Unit 4 drain line. Soil was sampled around the drain location and identified residual radioactivity. The calculated activity released resulted in an estimated dose of 3.32×10^{-6} mrem, well below Offsite Dose Calculation Manual limits (FPL 2013a, 2015a, 2015b, 2016i, 2016j, 2017d, 2017e, 2018j, 2018h, 2018k, 2019b, 2019c).

Table 3-6 summarizes the latest available radiological groundwater monitoring results that FPL has reported to the NRC for representative well locations, with the results compared to historical maximum observed concentrations. Monitoring well locations are depicted in Figure 3-27 below.

Table 3-6 Representative Groundwater and Storm Drain Monitoring Results for Tritium, Turkey Point Groundwater Protection Program, 2018 (in PicoCuries per Liter)

Well Number	First Quarter(a,b)	Second Quarter(a,b)	Third Quarter(a,b)	Fourth Quarter(a,b)	Previous 4-Year Maximum Concentration (Year-Quarter)
P-94-4	661	894	719	488	3,060 (2015-Q3)
PTN-MW-1S	<MDC	NA	<MDC	NA	80.5 (2014-Q3)
PTN-MW-1I	244	NA	433	NA	700 (2016-Q1)
PTN-MW-1D	1,540	NA	1,270	NA	2,310 (2015-Q3)
PTN-MW-4S	2.74	2.04	No result	<MDC	1,930 (2014-Q2)

Well Number	First Quarter[a,b]	Second Quarter[a,b]	Third Quarter[a,b]	Fourth Quarter[a,b]	Previous 4-Year Maximum Concentration (Year-Quarter)
PTN-MW-4I	23	2,420	2,310	<MDC	3,570 (2016-Q1)
PTN-MW-4D	2,830	2,840	2,790	<MDC	3,840 (2015-Q4)
PTN-MW-7S	936	818	603	643	1,070 (2015-Q4)
PTN-MW-7I	1,930	1,400	1,440	<MDC	2,400 (2015-Q3)
PTN-MW-7D	15.4	168	No result	178	2,370 (2014-Q1)
PTN-MW-8S	3,020	566	1,860	3,390	13,600 (2017-Q4)
PTN-MW-9S	690	775	403	943	798 (2017-Q4)
PTN-MW-11S	181	782	743	387	804 (2014-Q3)
PTN-MW-12S	755	541	907	757	1,140 (2016-Q1)
Northeast Storm Drain	545	150	473	7,470	9,990 (2017-Q4)
Southeast Storm Drain	Dry	769	858	822	13,000 (2017-Q4)
West Storm Drain	5,150	2,080	2,110	1,180	12,000 (2017-Q4)
CRF Storm Drain	No result	No result	Dry	Dry	<MDC

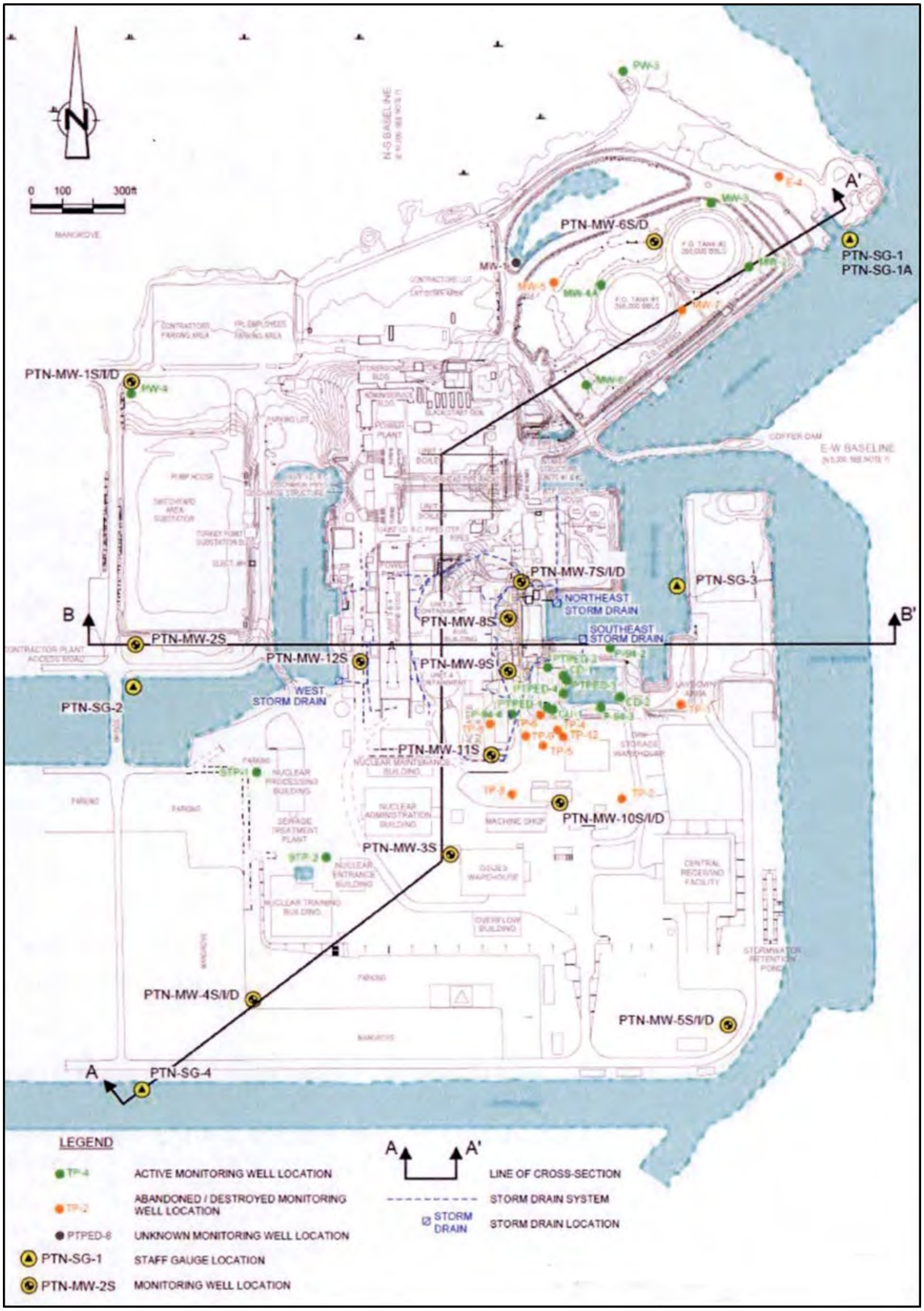
Notes: CRF=central receiving facility; MDC=minimum detectable concentration, value is less than the analytical MDC or less than 300 pCi/L tritium; NA=not applicable, as sampling not conducted or required for sampling period.

S, I, and D refer to approximate monitored depth below land surface: Shallow 20 feet (6 m), Intermediate 40 feet (12 m), and Deep 60 feet (18 m).

(a) FPL reports all results in pCi/L.

(b) FPL generally collects quarterly samples in January, April, July, and October.

Sources: FPL 2015b, FPL 2016j, FPL 2017d, FPL 2018k, FPL 2019c.



Source: Modified from FPL 2018k (Note: Cross-Sections Omitted)

Figure 3-27 Turkey Point Groundwater Protection Initiative Monitoring Well Locations

Based on these results, the NRC staff finds no apparent increasing trend in tritium concentration or a pattern indicating either a new inadvertent release or persistently high tritium concentrations that might indicate an ongoing inadvertent release from Turkey Point facilities to groundwater. In 2017 and 2018, the highest observed levels in Turkey Point groundwater were 13,600 pCi/L and 3,390 pCi/L, respectively, at well PTN-MW-8S. This location is near the Turkey Point Unit 3 refueling water storage tank, shown in Figure 3-27. Elevated tritium levels were also detected in storm drain locations, which likely represents tritium concentrations in the CCS during periods when storm drain outfalls are occasionally below the tidal mark in the canal system (FPL 2018k). Nevertheless, all results are less than the limits prescribed by FPL's Offsite Dose Calculation Manual (FPL 2013a) for the plant, which for tritium is 30,000 pCi/L, as groundwater at the site is not designated for potable use.

At the time of the NRC's onsite environmental audit in 2018 for the subsequent license renewal, FPL was preparing a site conceptual model as part of an effort to identify and characterize groundwater flow and the occurrence and migration of tritium at the FPL property, including locations such as: Turkey Point Units 1, 2, and 5, the diesel storage tank area, and portions of the intake and discharge canals. Other objectives of this effort include evaluation of potential human, ecological, or environmental receptors of tritium that might have been released to the groundwater and development of recommendations for additional investigations and long-term monitoring (FPL 2018h).

With respect to unplanned, non-radiological releases, FPL reported no accidental spills or similar releases of nonradioactive substances, including petroleum products, at Turkey Point over the past 5 years, nor any associated notices of violation issued to FPL for such releases (FPL 2018f, FPL 2018h). The NRC staff's review of available information and regulatory databases found no documented instances of accidental spills of chemical or petroleum products to groundwater that resulted in a regulatory action over the last 5 years.

3.5.2.3 Groundwater Use

Section 2.2.2 of NUREG–1437, Supplement 5 describes water use and sanitary wastewater management for Turkey Point operations (NRC 2002c). As indicated in that section, water for Turkey Point process makeup (e.g., primarily demineralizer water makeup), potable water, and fire protection water uses was obtained from the Miami-Dade Water and Sewer Department (MDWSD). Sanitary wastewater was being processed in an onsite treatment plant and discharged to groundwater (Biscayne aquifer) through an onsite injection well (i.e., IW-1). That section further states that no surface water or groundwater was being withdrawn for use as makeup water for the CCS at that time. The NRC staff incorporates the information in NUREG–1437, Supplement 5, Section 2.2.2 (NRC 2002c: 2-5, 2-17, 2-18), here by reference. The following discussion presents new information regarding groundwater use for Turkey Point operations, beyond the information in NUREG-1437, Supplement 5.

In southeast Florida and in Miami-Dade County where Turkey Point is located, groundwater aquifers are used both as a water supply and as a reservoir for wastewater disposal via deep well injection. Nearly all of the potable water supplied by the MDWSD to southern Miami-Dade County comes from the Biscayne aquifer (MDC 2018b, NRC 2016a) (see Section 3.5.2.2, "Groundwater Quality"). The exception is water from the County's Alexander Orr, Jr. water treatment plant, which mixes some brackish groundwater from the Upper Floridan aquifer with Biscayne aquifer groundwater (NRC 2016a).

In 2015, groundwater withdrawals in Miami-Dade County totaled 409.2 mgd (1.55 million m^3/day) from freshwater sources and 40.5 mgd (153,300 m^3/day) from saline sources. Withdrawals for public water supply comprised the largest use including 338.9 mgd (1.28 million m^3/day) from freshwater sources and 13.0 mgd (49,200 m^3/day) from saline sources. Withdrawals for power generation included 1.28 mgd (4,850 m^3/day) from freshwater sources and 27.5 mgd (104,000 m^3/day) from saline sources (USGS 2018a).

The MDWSD continues to supply potable water to Turkey Point for drinking and fire protection water uses. Sanitary wastewater disposal continues to be accomplished through an FDEP permitted injection well, as well as by septic tanks (FPL 2018f).

FPL completed installation of a replacement water treatment plant in 2017, which is designed to supply pure/ultrapure (demineralized) water for Turkey Point uses. The new system can treat either municipally supplied water (i.e., from the MDWSD) or groundwater from the Upper Floridan aquifer. The use of groundwater is intended to reduce FPL's use of MDWSD water by 1 mgd (3,800 m^3/day) and associated costs. Wastewater from the new treatment plant is discharged to the CCS (FPL 2018f). Section 3.10.4.3, "Public Water Supply," of this SEIS describes the MDWSD public water supply system, and Section 3.1.5, "Nonradioactive Waste Management Systems," describes nonradioactive waste management systems that support Turkey Point Units 3 and 4 operations.

Currently, FPL uses onsite groundwater withdrawn from the Biscayne and Upper Floridan aquifers for a variety of applications in support of Turkey Point operations, as well as for other activities conducted on the Turkey Point site unrelated to Units 3 and 4. These principal uses include withdrawals of brackish water from the Upper Floridan aquifer for freshening of the CCS, operation of a recovery well system and associated underground injection well to extract and dispose of hypersaline groundwater from the Biscayne aquifer, operation of Biscayne aquifer marine wells that withdraw salt water to supplement CCS freshening, and operation of Upper Floridan Aquifer site production wells for various onsite uses (e.g., Unit 5 usage).

Table 3-7 summarizes FPL's reported groundwater withdrawals associated with these well systems for the period from January 2015 through December 2018, except as noted. In 2018, FPL's groundwater withdrawals from the Biscayne aquifer totaled about 4,630 mgy (17.5 million m^3/year), or approximately 12.7 mgd (48,700 m^3/day). For the Upper Floridan aquifer, withdrawals totaled approximately 7,397 mgy (28.0 million m^3/year), or approximately 20.3 mgd (76,800 m^3/day).

Table 3-7 Groundwater Withdrawals at the Turkey Point Site

	Withdrawals (mgy)			
Year	**UFA Site Production Well System (PW-1, PW-3, PW-4)**	**Biscayne Aquifer Marine Well System (PW-1 (test), SW-1, and SW-2)**	**UFA Freshening Well System (F-1, F-3, F-4, F-5, F-6)**	**Biscayne Aquifer Testing and Recovery Well System (RW-1–RW-10)**
2015	3,339.6	6,065	0.0	0.0
2016	2,237.2	0.0	1,051.6	1,326[(a)]
2017	2,361.9	4,031.7	4,771.8	4,912.1[(a)]
2018	2,761.8[(b)]	0.0[(c)]	4,634.9[(d)]	4,630.01[(e)]

Key: mgy=million gallons per year, UFA=Upper Floridan aquifer.

Note: Some reported values have been rounded. To convert million gallons per year (mgy) to million cubic meters (m^3), divide by 264.2.

(a) Withdrawals associated with hypersaline extraction and the deep well injection program, using four interim production/extraction wells located in the CCS, which began operations on September 28, 2016.

(b) Production well system withdrawals for calendar year 2018 compiled from pumpage report data (SFWMD 2019a).

(c) Marine wells were not operated during the period January through June 2018 (FPL 2018p).

(d) Total calendar year 2018. Freshening well system withdrawals for the period January 2018 through September 2018 (FPL 2018p), supplemented by 4th quarter 2018 pumpage report data (SFWMD 2019a).

(e) Total calendar year 2018. Hypersaline recovery well operations for the period January 2018 through September 2018, including operation of four demonstration (interim production/extraction) wells until May 7, 2018, followed by startup of recovery well system wells RW-1 through RW-10, which began full-scale operations on May 15, 2018 (FPL 2018p). Supplemented with 2018 4th quarter pumpage report data (SFWMD 2019b).

Sources: Compiled from FPL 2017b, FPL 2018h, FPL 2018l, FPL 2018o, FPL 2018p, SFWMD 2019a, SFWMD 2019b.

The nature of these withdrawals and the applicable regulatory requirements governing them are further described below.

Turkey Point Site Water Supply Systems

Water for cooling and process makeup water for Turkey Point Unit 5 is obtained from Upper Floridan aquifer site production wells PW-1, PW-3, and PW-4, depicted in Figure 3-28. These wells were commissioned in February 2007 (FPL 2018f). The wells are authorized under FPL's modified site certification and associated conditions of certification for the Turkey Point site. The wells range in depth from 1,242 to 1,247 feet (378.6 to 380.1 m), each with a pump capacity of 5,000 gpm (18,900 L/min) (State of Florida Siting Board 2016, FDEP 2016b). The 2016 Conditions of Certification specifically authorizes the withdrawal of 14.06 mgd (53,200 m^3/day) of groundwater from the upper production zones of the Upper Floridan aquifer for cooling water for Unit 5 and process water for Units 1, 2, 3, 4, and 5 (FDEP 2016b). In March 2018, FPL began using approximately 1.1 mgd (4,200 m^3/day) of groundwater from the

Upper Floridan aquifer site production wells as makeup water to the pure/ultrapure (demineralized) makeup water treatment system for Turkey Point Units 3 and 4 primary and secondary system uses. This usage replaced approximately 0.65 mgd (2,500 m^3/day) of potable water that had been supplied by the MDWSD from the Newton Wellfield (FPL 2018h).

Source: Modified from FPL 2017b

Figure 3-28 Location of Groundwater Production Wells on the Turkey Point Site

FPL completed installation of three marine wells in the 2015 timeframe (i.e., wells PW-1 (test), SW-1, SW-2) to provide water for salinity reduction in the CCS (i.e., CCS freshening) (FPL 2018f, FPL 2018m). These wells are located on the Turkey Point peninsula and withdraw from the upper portion of the Biscayne aquifer (Figure 3-28). Consequently, the marine wells withdraw saltwater (Golder Associates 2016). Before being converted to a production well in late 2014 and early 2015, PW-1 was originally installed in 2009 as a 30-inch (76-cm) diameter test well for evaluation of a radial collector well system for proposed new reactors, Turkey Point Units 6 and 7 (FPL 2018m). Well PW-1 has a total depth of 46 feet (14 m), with an open borehole from 22 to 46 feet (6.7 to 14.0 m) below the casing (HDR Engineering 2009). It is equipped with a 7,000-gpm (26,500-L/min) pump (FPL 2018m). Marine wells SW-1 and SW-2 are 36-inches (91-cm) in diameter. The two wells are completed to total depths of 56 and 55 feet (17.1 and 16.8 m), respectively, with the lower 30 feet (9.1 m) of each well terminating in an open borehole. Each of these wells has a 12,500-gpm (47,300 L/min) rated capacity pump (FPL 2018m). Together, the three wells have a combined production capacity of approximately 45 mgd (170,300 m^3/day) (FPL 2018f). Notwithstanding this nominal production capacity, the total water volume that can be withdrawn and conveyed to the intake canal area is limited by considerations associated with measurement of the ultimate heat sink temperature and compliance with the technical specifications in the Turkey Point, Units 3 and 4 operating licenses. Specifically, the total flow must be less than or equal to 23,400 gpm (88,600 L/min) when only one Turkey Point unit is operating and 41,600 gpm (157,500 L/min) when both Units 3 and 4 are operating (FPL 2018m).

Operation of the marine wells does not require a groundwater consumptive use permit from the SFWMD because saltwater is not regulated by the State (FPL 2018f). In general, users of seawater, or reclaimed water, are not required to obtain water use permits (SFWMD 2015). The water withdrawn from the marine wells has an average salinity of around 36 PSU (FPL 2017b). Historically, the salinity of marine well water has ranged from about 34 PSU to nearly 40 PSU with chloride concentrations ranging from approximately 20,000 to 23,000 mg/L (FPL 2016f). FPL has used the wells during periods of peak CCS salinity to moderate salinity rise (FPL 2018f). As stipulated under the 2015 Consent Agreement (MDC 2015a) between FPL and Miami-Dade County, the marine wells may only be used to lower salinity in the CCS under “extraordinary circumstances.” As a result, FPL reports that the wells are used in response to extraordinary circumstances or upset recovery to support regulatory requirements (FPL 2018f, FPL 2018m).

In 2016, FPL installed five additional production wells (F-1, F-3, F-4, F-5, and F-6) to provide water from the Upper Floridan aquifer for use in freshening the CCS (Figure 3-28). As previously described, the freshening wells are authorized under FPL’s modified site certification and associated conditions of certification for the Turkey Point site, which permit a total withdrawal of 14 mgd (53,000 m^3/day) for salinity reduction (State of Florida Siting Board 2016, FDEP 2016b). The wells are artesian in nature (i.e., require no pumping) and flow is conveyed directly into the CCS. The 20-inch (51-cm) diameter wells range in depth from 1,000 to 1,250 feet (304.8 to 381 m) (FDEP 2016b, FPL 2018f). Each well is authorized to have a maximum flow of 2,500-gpm (9,460 L/min) (FDEP 2016b).

As described in Section 3.5.2.2, “Groundwater Quality,” in May 2018, FPL completed and began operation of a recovery well system to meet the groundwater remediation objectives specified in the 2015 Consent Agreement (MDC 2015a) with Miami-Dade County and the 2016 Consent Order with the FDEP (2016a). The system consists of 10 hypersaline groundwater recovery (extraction) wells (designated RW-1 through RW-10) completed in the Biscayne aquifer and one deep injection well (DIW-1) for disposal of hypersaline groundwater (Figure 3-25). These wells replaced four demonstration wells that FPL used for hypersaline groundwater recovery testing from September 2016 through April 2018.

The 24-inch (61-cm) recovery wells are each drilled to a total depth of 110 feet (33.5 m) and are cased to a depth of 70 feet (21 m) below land surface. Each recovery well is equipped with a 1,042-gpm (3,900-L/min) electric pump, giving the well system a combined extraction capacity of 15 mgd (56,700 m^3/day) (SFWMD 2017a). Each extraction well pump discharge is fitted with backflow prevention, a magnetic flow meter, a pressure transducer, a pump discharge pressure transmitter, sample tap, and an air release valve. Each well is also equipped with a water quality monitoring station. The wells are operated with programmable logic controllers and variable frequency driven well motor pump sets, and they are controlled and continuously monitored by remote secure radio communication telemetry to a main control building located near the deep injection well. The wells are connected in parallel by 14-inch (36-cm) diameter piping which runs to a 28-inch (71-cm) header that conveys the extracted hypersaline groundwater to deep injection well DIW-1. A total of about 9.5 mi (15 km) of pressure-rated piping is used in the conveyance system (FPL 2018h). Recovery well operations are permitted under an SFWMD-issued individual water use permit (Permit No. 13-06251-W) (FPL 2018f, SFWMD 2017a). The permit specifies a maximum monthly withdrawal allocation of 465 million gallons (1.76 million m^3) (SFWMD 2017a).

The deep injection well DIW-1 discharges extracted hypersaline water to the Boulder Zone at a depth of approximately 3,200 feet (975 m). DIW-1 is constructed of concentric piping (casing strings) ranging from 64-inch (163-cm) diameter steel casing in the upper interval to 33 feet (10 m) below land surface, 24-inch (61-cm) diameter steel casing to 2,985 feet (910 m) below land surface, and followed by an 18-inch (46-cm) diameter liner to a depth of 2,975 feet (907 m) below land surface. The liner tubing is fiberglass reinforced pipe with a fluid filled annulus. The total depth of the well borehole is 3,230 feet (984.5 m) below land surface (FDEP 2013).

The deep injection well DIW-1 is paired with a dual-zone monitoring well (DZMW-1), which is completed in the Floridan aquifer with upper and lower monitoring zones at 1,450 to 1,490 ft (442 to 454 m) below land surface and 1,860 to 1,905 feet (567 to 581 m) below land surface (FDEP 2013). Operation of DIW-1 is authorized under FDEP Permit No. 293962-002-UC (FPL 2013, FDEP 2018d). The maximum permitted injection rate for DIW-1 is 10,826 gpm (41,000 L/min), or 15.59 mgd (59,000 m^3/day), and the well is required to be periodically tested for injectate confinement (FDEP 2013).

The Boulder Zone is located in the Lower Floridan aquifer and is overlain by a confining layer that retards upward migration of wastewater (FPL 2018f). The FDEP permits FPL and others to discharge treated sewage and other wastes through injection wells into the Boulder Zone. All Boulder Zone underground injection wells must be permitted and monitored by the FDEP underground injection control program. As an example, the Miami-Dade Water and Sewer Department's South District Wastewater Treatment Plant located approximately 9 mi (14 km) north of the Turkey Point site disposes of municipal wastewater through as many as 13 deep injection wells into the Boulder Zone (NRC 2016a).

Other Water Supply Wells

While the Biscayne aquifer is the principal source of potable water supplied by the Miami-Dade Water and Sewer Department (see Section 3.10.4.3, "Public Water Supply"), as discussed in Section 3.5.2.2, "Groundwater Quality," the Biscayne aquifer is not a source of potable water in the vicinity of the Turkey Point site. Other than FPL-owned water wells, described above, there are no potable water wells (drawing from either the Biscayne or Floridan aquifer systems) within the Turkey Point site boundary.

There are no registered groundwater supply wells within a 2-m (3.2-km) band of the Turkey Point site boundary (FPL 2018f). Relative to the Turkey Point site, the nearest mapped water supply wells are located about 5 mi (8 km) west of the western boundary of the CCS and are used to support mining operations (FDOH 2018a).

As for public water supply sources, the nearest wells are located about 6 mi (10 km) from the northwest corner of the CCS and approximately 7 mi (11 km) from the center of the Turkey Point plant complex. These wells are located at Newton Field (i.e., the Newton Wellfield) and are operated by Miami-Dade County (see Figure 3-17) (FDOH 2018a, MDC 2006, MDC 2018c, NRC 2016a).

Potable water supply for the Florida Keys comes from Biscayne aquifer wells and an Upper Floridan aquifer well located west of Florida City at the Florida Keys Aqueduct Authority's J. Robert Dean Water Treatment Plant. These facilities are located approximately 9.5 mi (15 km) west, northwest of the western boundary of the CCS (FDOH 2018a, FKAA 2019a, MDC 2006, MDC 2018c, NRC 2016a). The authority also maintains two seawater desalinization facilities located in the Florida Keys that can be used in emergency situations to meet potable water needs (FKAA 2019a).

As required by the Safe Drinking Water Act of 1974 and in accordance with applicable Federal and State regulations and programs, Miami-Dade County as well as the Florida Keys Aqueduct Authority are responsible for providing necessary treatment of source water to potable (drinking water) standards and to protect water sources from contamination through wellhead protection and related programs (40 CFR 141, 40 CFR 143, FAC 62-528, FAC 62-521, MDC 2006). In addition, Miami-Dade County and the Florida Keys Aqueduct Authority have implemented measures to address saltwater intrusion (encroachment) (described in Section 3.5.2.2) and the effects of the CCS on water supplies, which include monitoring, mitigation, and adaptation (FKAA 2016, FKAA 2019, Mcthenia et al. 2017, MDC 2019a).

3.6 Terrestrial Resources

This section describes the terrestrial resources of the affected environment, including the surrounding ecoregion. The terrestrial resources include plant and animal species, vegetative communities, and important habitats present on or near the Turkey Point site. This section also describes important species and habitats that potentially may be present on or near the Turkey Point site. Plants and animals federally listed as endangered or threatened are discussed in Section 3.8, "Special Status Species and Habitats."

3.6.1 Vegetative Communities

The Turkey Point site is located on the western edge of Biscayne Bay and lies within the Mangrove and Coastal Glades physiographic province (McPherson and Halley 1996). This area includes a broad band of wetlands at or near sea level that is often flooded by tides or freshwater runoff. The region's ecology is directly tied to the natural seasonal hydrologic fluctuations. The NRC staff's EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG–2176) (NRC 2016a), Section 2.4.1.1 and Tables 2-2 and 2-3 describe the physiographic province, the general ecology of the Turkey Point site, and the characteristics of various habitats on and near the Turkey Point site. Section 2.4.1.1 of NUREG-2176 (NRC 2016a) also summarizes the results of vegetation surveys of the Turkey Point site through 2011. The NRC staff incorporates the above information from NUREG–2176, Section 2.4.1.1 and Tables 2-2 and 2-3 into this SEIS by reference (NRC 2016a: 2-76 to 2-77; Tables 2-2 and 2-3).

3.6.2 Marsh, Mangrove, and Tree Island Semiannual Monitoring

Since 2010, FPL has commissioned Ecology and Environment, Inc. to perform ongoing, semiannual ecological monitoring of the Turkey Point site and surrounding environment as a requirement of the FDEP's Conditions of Certification in connection with the Turkey Point extended power uprate and the SFWMD's Fifth Supplemental Agreement. With respect to the terrestrial environment, Ecology and Environment monitors marsh, mangrove, and tree islands to characterize and observe changes in ecological characteristics over time. Researchers monitor a total of 32 20-m x 20-m (66-ft x 66-ft) plots (16 marsh, 4 tree island, and 12 mangrove) along 12 transects (6 marsh and 6 mangrove). Within each plot, 1-m x 1-m (3.2-ft x 3.2-ft) and 5-m x 5-m (16-ft x 16-ft) subplots have been designed to measure changes in woody species and the herbaceous community, respectively. Six plots (four marsh and two mangrove) serve as reference plots. Ecology and Environment began vegetation monitoring in October 2010, prior to the Turkey Point extended power uprate. During each survey, researchers measure the percent cover, species diversity, plant height, and biomass within each plot as well as other factors that may indicate changes in the health of the vegetation and habitat. Ecology and Environment surveyed vegetation four times each year (in February, May, August, and October) through 2013. Since 2013, FPL (2018o) has maintained the same methodology but has reduced ecological monitoring frequency, and tree island plots are now only monitored for porewater. Since that time, ecological monitoring has continued as follows:

- marsh plots: quarterly
- mangrove plots: annually
- tree island plots: semiannually (porewater only)

FPL's (2012a) report, "Turkey Point Plant Comprehensive Pre-Uprate Monitoring Report, Units 3 & 4 Uprate Project," describes FPL's ecological monitoring methodology in detail.

<u>Marsh Monitoring</u>

Sawgrass (*Cladium jamaicense*) marshes are the most common type of freshwater wetland near Turkey Point and within FPL's ecological monitoring plots. This type of marsh experiences flooding for most of the year. The relative abundance of sawgrass compared to other species tends to be positively correlated with both hydroperiod length (or time in which the area is flooded) as well as water depth during the hydroperiod (UF undated, Foti et al. 2012). Sawgrass thrives in harsh physiological conditions, including flooding and deep water, that few other plants can tolerate (Brown et al. 2006). Sawgrass stands grow so densely that few other species can successfully establish in the limited remaining space. For these reasons, plant diversity is generally low within sawgrass marshes.

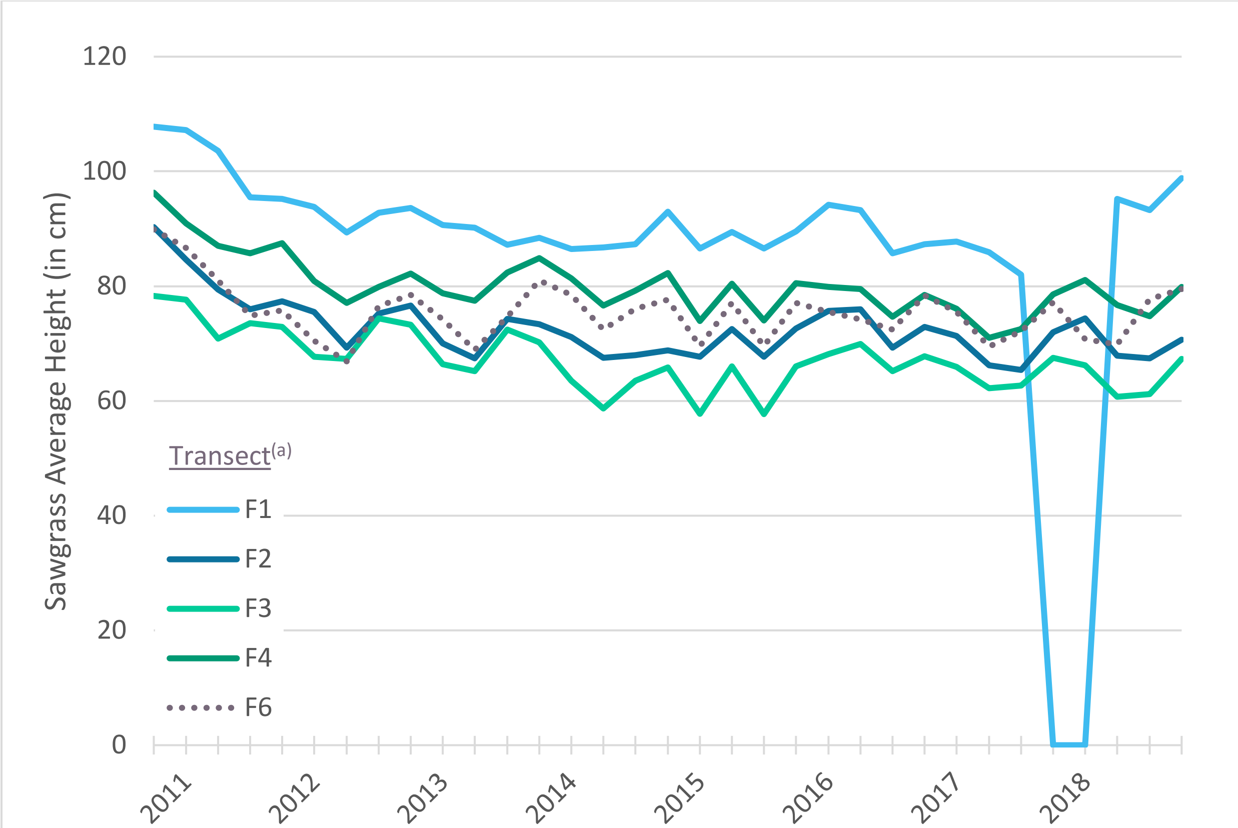
Following sawgrass, the next most common plant species in nearby freshwater marshes is spikerush (*Eleocharis cellulose*). Within FPL's ecological monitoring plots, species diversity generally ranges from one to three plant species per plot (FPL 2012a, FPL 2014b, FPL 2016a, FPL 2016b, FPL 2017a, FPL 2018o), which is typical for southern Everglades sawgrass marshes (Childers et. al. 2006, Foti et al. 2012).

To examine the characteristics of the freshwater marshes on and near the Turkey Point site, the NRC staff used FPL's monitoring data to evaluate several ecological metrics over time. These metrics include sawgrass percent cover, sawgrass average height, and sawgrass live biomass, among others, over the available data period of October 2010 through November 2018. The discussion below includes five freshwater marsh transects: F1 through F4 are test transects and lie adjacent to the CCS, and F6 is the reference transect and lies west of the CCS. The staff omitted transect F5 because this transect is dominated primarily by red (*Rhizophora mangle*) and white (*Laguncularia racemosa*) mangrove, and sawgrass is not present there.

<u>Sawgrass Percent Cover</u>. Percent cover is an ecological indicator of what species are dominating an area. It is expressed as a percent of a unit of area. Percent cover reflects the amount of soil, water, and nutrients that a species can use to create biomass. As part of FPL's ecological monitoring efforts, researchers record sawgrass percent cover by cover class (e.g., 0-1 percent, 2-5 percent, 6-25 percent, 26-50 percent, 51-75 percent, and 76-100 percent). From 2010 through 2018, all freshwater marsh transects (F1 through F4 and F6) within the study area consistently exhibited between 2 to 25 percent sawgrass cover with only small seasonal changes (FPL 2012a, FPL 2012c, FPL 2013c, FPL 2014e, FPL 2015c, FPL 2016d, FPL 2017f, FPL 2018s, FPL 2019f). Notably, plot F1-1 within transect F1 experienced a complete die-off of sawgrass in fall 2017. Researchers attributed the die-off to the storm surge associated with Hurricane Irma, which made landfall in Southern Florida in September 2017 (FPL 2018o). By May 2018, sawgrass within the F1 transect had begun recovering, and cover class was recorded as 0 to 1 percent within this plot (FPL 2018o). Researchers reported similar results in this plot in November 2018 (FPL 2019f). Within the F1 transect as a whole, FPL (2019f) reported cover to be 5.8 percent.

<u>Sawgrass Average Height</u>. Plant height, when compared across sites, can be a useful measure of whether local ecological conditions are inhibiting or promoting growth. Within the study area, sawgrass in freshwater marsh transects has exhibited seasonal fluctuations in height. Greater heights are generally observed in fall and winter than in spring and summer. From October 2010 through February 2012, average sawgrass height within all transects (test and reference) decreased. Sawgrass height has fluctuated ever since without showing a consistent upward or downward trend. As explained above, plot F1-1 experienced a complete die-off of sawgrass in fall 2017. By May 2018, sawgrass within this plot had begun to recover, and the newly regrown sawgrass within the F1 transect was of greater height than pre-hurricane values within the same transect. Figure 3-29 depicts average sawgrass height by transect from October 2010 through November 2018.

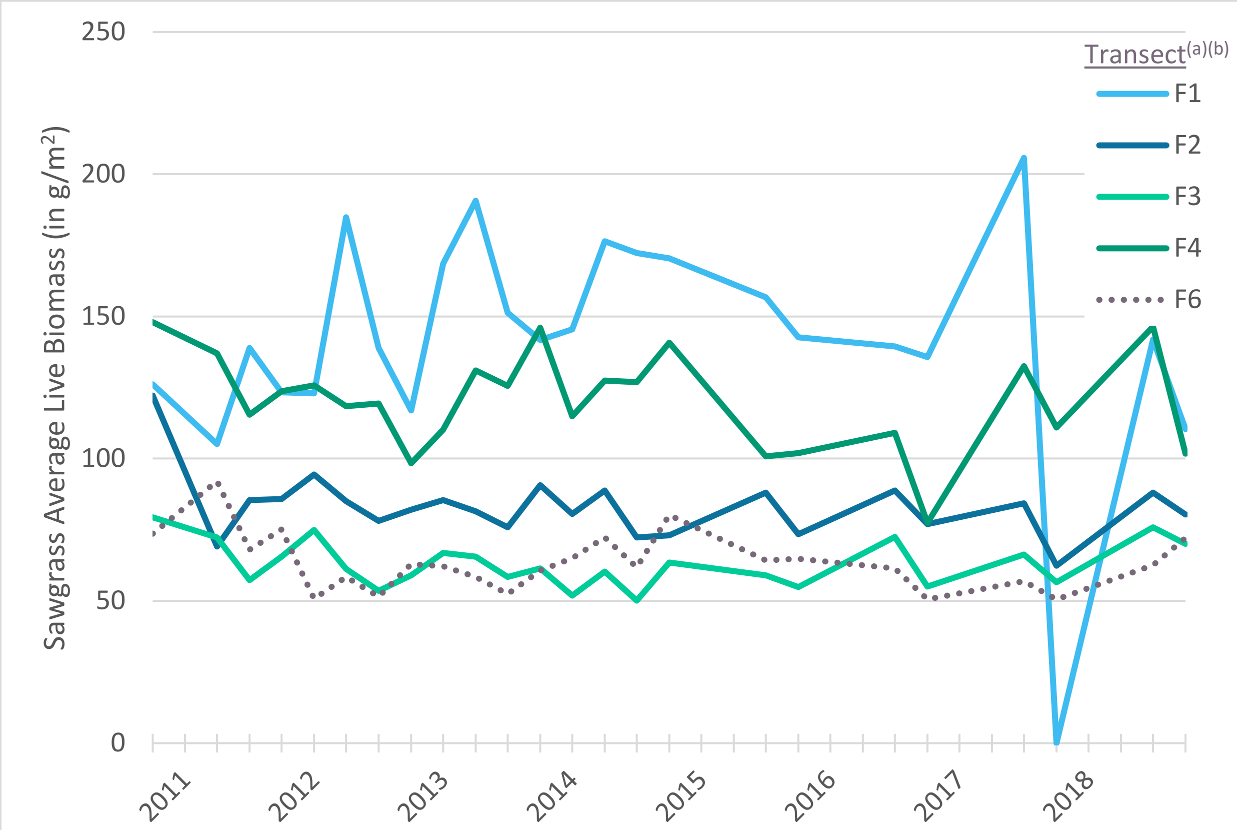
<u>Sawgrass Live Biomass</u>. Live biomass is a measure of the mass of living or recently dead biological material. For plants, live biomass is expressed as dry weight per unit of area. Biomass can be an indicator of ecological health and potential productivity of an area. Within the study area, sawgrass live biomass in test and reference transects has fluctuated throughout the available data period with no consistent upward or downward trend. More recently, live biomass decreased in August and November 2016, increased by February 2017, and remained at similar or higher levels in May 2017. The plot F1-1 die-off is reflected in the sharp decline in biomass for transect F1 in November 2017. However, by August 2018, biomass recovered to within the range of levels observed between 2015 and 2016. Figure 3-30 depicts average sawgrass biomass by transect from October 2010 through November 2018.



[a] Marsh transects depicted in figure are those in which at least one plot within the transect is dominated by sawgrass. Transects include all plots within the transect, and sawgrass height for a given transect is the average of all transect plots. F1 through F4 are test transects. F6 is the reference transect.

Sources: FPL 2012a, FPL 2012c, FPL 2013c, FPL 2014e, FPL 2015c, FPL 2016d, FPL 2017f, FPL 2018s, FPL 2019f

Figure 3-29 Sawgrass Average Height in Freshwater Marsh Transects, 2010-2018



[(a)] Marsh transects depicted in figure are those in which at least one plot within the transect is dominated by sawgrass. Transects include all plots within the transect, and sawgrass biomass for a given transect is the average of all transect plots. F1 through F4 are test transects. F6 is the reference transect.

[(b)] Beginning in 2015, FPL reduced sampling effort to twice per year (August and November).

Sources: FPL 2012a, FPL 2012c, FPL 2013c, FPL 2014e, FPL 2015c, FPL 2016d, FPL 2017f, FPL 2018s, FPL 2019f

Figure 3-30 Sawgrass Average Live Biomass in Freshwater Marsh Transects, 2010-2018

Other Ecological Metrics. In addition to the ecological metrics described above, FPL samples freshwater marsh sawgrass within the study area for annual net primary productivity, sclerophylly (a measure of leaf hardness or toughness), and leaf nutrient and stable isotopic composition. FPL also samples marsh porewater for conductance, temperature, and nutrients (nitrogen, ammonia, and phosphorus). FPL's reports for the available data period show data that are generally consistent since monitoring began with no clear upward or downward trend or differences among transects that can be attributed to proximity of transects to the CCS. FPL's ecological monitoring data suggest that the observed changes and fluctuations within freshwater marshes near Turkey Point are attributable to landscape-scale environmental factors, such as hydroperiod length, overall water depth, and storm surges, and that proximity to the CCS does not noticeably influence marsh ecology. Additionally, the observed fluctuations in sawgrass height and live biomass suggest a high degree of natural variability influenced by multiple environmental parameters.

FPL's (2018o) 2018 annual monitoring report describes the results of ecological monitoring performed from June 1, 2017, through May 31, 2018. The staff incorporated data from this monitoring report as well as data available on FPL's Electronic Data Management System (FPL 2019f) for the remainder of 2018 (i.e., June 1, 2018, through December 31, 2018) into the above discussion on freshwater marsh monitoring. Data from 2018 support the NRC staff's previous conclusion that the CCS does not have a discernable ecological impact on the surrounding areas and that there is no clear evidence of CCS water in the surrounding marsh and mangrove areas from a groundwater pathway (FPL 2018o). Although FPL found some ecological changes during the reporting period, these changes were seasonally and meteorologically driven. For instance, as explained above, one freshwater marsh plot (F1-1) experienced a complete die-off of sawgrass in connection with Hurricane Irma, which made landfall in Southern Florida in September 2017. This plot began exhibiting recovery during subsequent sampling events. As discussed in the next section below, mangroves continued to exhibit overall stable structure and composition in 2018.

Mangrove Monitoring

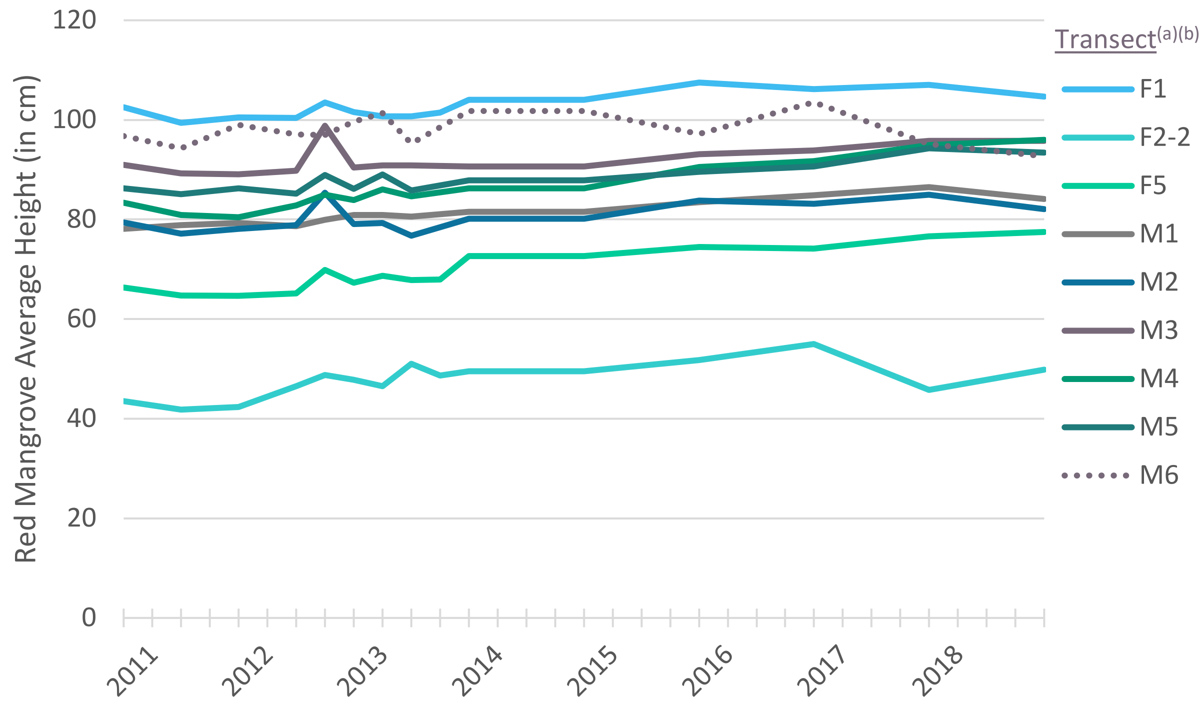
Red mangrove dominates the scrub mangrove habitat near Turkey Point and within FPL's ecological monitoring plots. Red mangrove forests tend to have low plant diversity due to the dominance of red mangrove and because few species have adapted to grow in the physically demanding saline environment within which these forests form. White mangrove and black mangrove (*Avicennia germinans*) are also present, but to a much lesser degree.

To examine the characteristics of the mangrove habitat on and near the Turkey Point site, the NRC staff used FPL's monitoring data to evaluate several ecological metrics over time. These metrics include mangrove percent cover, mangrove average height, and mangrove live biomass, among others, over the available data period of October 2010 through November 2018. The discussion below includes six mangrove transects: M1 through M5 are test transects and lie adjacent to the CCS to the north, east, and south; M6 is the reference transect and lies south of the CCS.

Red Mangrove Percent Cover. From 2010 through 2018, percent red mangrove cover in mangrove transects has remained consistent and has exhibited neither rapid declines nor rapid growth. Most plots exhibit 6 to 25 percent red mangrove cover. Plots M1-1, M1-2, and M2-2 exhibit 26 to 50 percent red mangrove cover.

Red Mangrove Average Height. Scrub mangrove forests typically have trees of less than 5 ft (1.5 m) in height (Lugo and Snedaker 1974). Trees measured within the six mangrove transects are consistent with this classification. From 2010 through 2018, red mangrove height has remained consistent or increased slightly within all transects. This suggests that mangroves within the study area are slow-growing and that no noticeable die-off has occurred. Slow growth is typical in dwarf mangrove habitats because of nutrient limitations, increased salinities associated with reduced tidal flushing, and other stressors that contribute to harsh growing conditions. Figure 3-31a depicts average red mangrove height by transect from October 2010 through November 2018.

Red Mangrove Live Biomass. Within the study area, red mangrove biomass has fluctuated within most transects with no consistent increasing or decreasing trend over time. In its 2017 annual monitoring report, FPL (2017a) noted decreasing biomass in mangrove plots M1-2 and M3-2 over the previous 2 years, although percent cover and height have remained relatively consistent in these plots. In its 2018 report, FPL's (2018o) data indicate that biomass in plot



(a) M1 through M5 are test transects. M6 is the reference transect. Freshwater marsh transects F1, F2 (plot F2-2 only), and F5 are included in table because they contain red mangrove for which height is sampled.

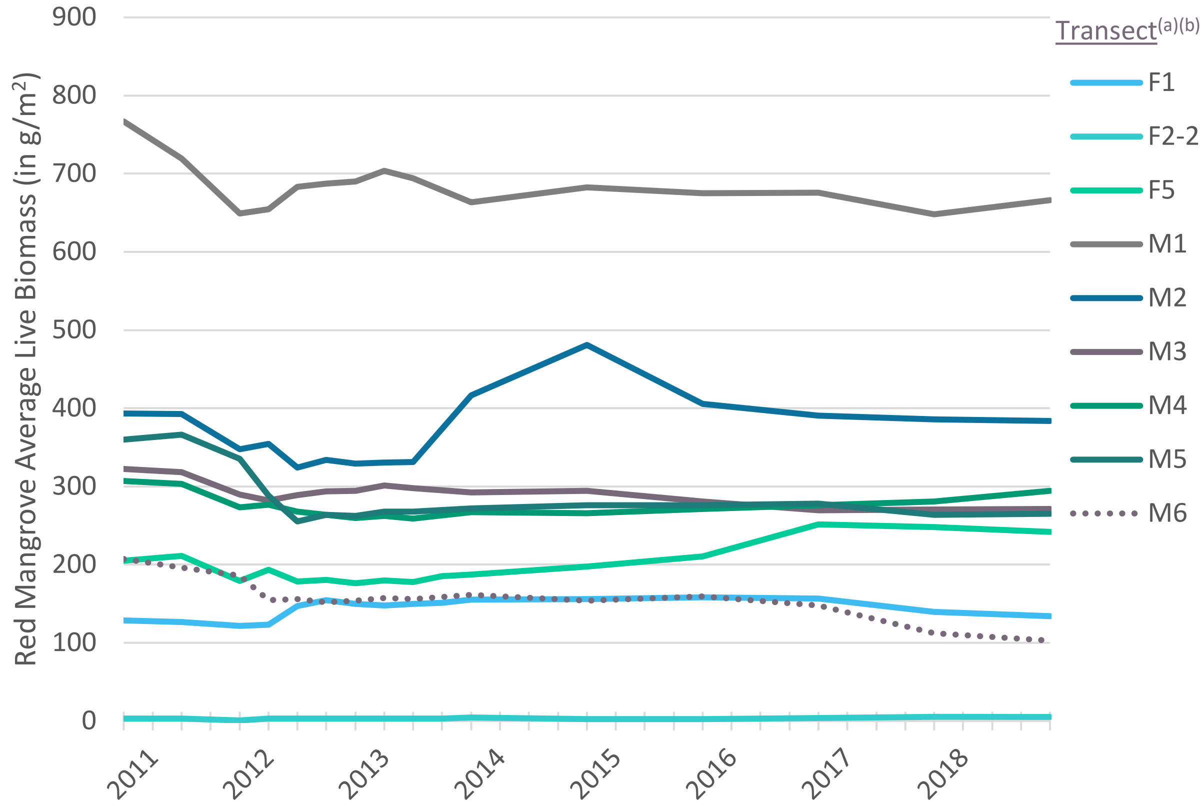
(b) In 2010 and 2011, FPL measured mangrove height biannually. In 2012 and 2013, FPL measured mangrove height quarterly. Beginning in 2014, FPL measured mangrove height annually in November.

Sources: FPL 2012a, FPL 2012c, FPL 2013c, FPL 2014e, FPL 2015c, FPL 2016d, FPL 2017f, FPL 2018s, FPL 2019f

Figure 3-31a Red Mangrove Average Height in Mangrove Transects, 2010-2018

M3-2 increased over the most recent monitoring period. Thus, the 2-year decreasing trend may have been part of natural ecological variation within this plot. Biomass in plot M1-2, however, continued to decrease for a third year in 2018. FPL (2017a, 2018o) intends to continue monitoring these plots in the future. The reference mangrove plots (M6-1 and M6-2), which are directly connected to Biscayne Bay, experienced a decrease in biomass (as well as height) following Hurricane Irma in 2017. The storm surge and associated winds likely impacted these sites more significantly than other mangrove plots that have fringe mangrove forests protecting them from the shoreline. FPL (2018o) also observed spatial variation in biomass among mangrove plots. For instance, plots M1-1 and M2-2 exhibit the highest biomass because of the density at which mangrove trees are growing (approximately 700 individuals per 25 m^2 (270 ft^2)) (FPL 2018o). Conversely, plot M6-1, which has some of the tallest trees among the mangrove plots, has the third lowest biomass due to the low tree density (24 individuals per 25 m^2 (270 ft^2)) (FPL 2018o). These differences highlight the natural landscape variations present in the local ecosystem. Figure3-31b depicts average red mangrove live biomass by transect from October 2010 through November 2018; Figure 3-32 depicts red mangrove live biomass in plots M1-2 and M3-2 over the same period.

Other Ecological Metrics. As within freshwater marsh transects, FPL samples mangroves within the study area for annual net primary productivity, sclerophylly, and leaf nutrient and stable isotopic composition. FPL also samples mangrove porewater for conductance, temperature, and nutrients (nitrogen, ammonia, and phosphorus). FPL's reports for the available data period show data that are generally consistent since monitoring began with no clear upward or downward trend or differences among transects that can be attributed to the proximity of transects to the CCS.

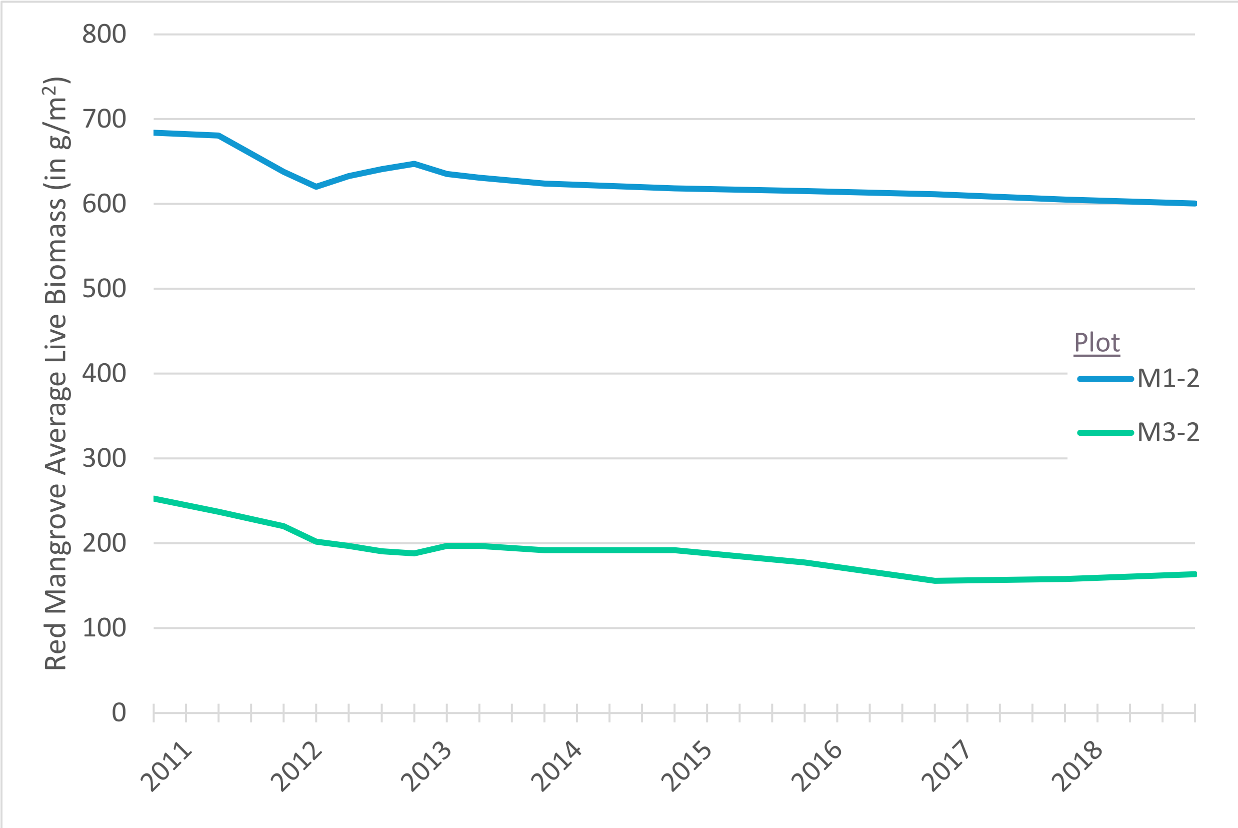


(a) M1 through M5 are test transects. M6 is the reference transect. Freshwater marsh transects F1, F2 (plot F2-2 only), and F5 are included in the table because they contain red mangrove for which biomass is sampled.

(b) In 2010 and 2011, FPL measured mangrove biomass biannually. In 2012 and 2013, FPL measured mangrove biomass quarterly. Beginning in 2014, FPL measured mangrove biomass annually in November.

Sources: FPL 2012a, FPL 2012c, FPL 2013c, FPL 2014e, FPL 2015c, FPL 2016d, FPL 2017f, FPL 2018s, FPL 2019f

Figure 3-31b Red Mangrove Average Live Biomass in Mangrove Transects, 2010-2018



Sources: FPL 2012a, FPL 2012c, FPL 2013c, FPL 2014e, FPL 2015c, FPL 2016d, FPL 2017f, FPL 2018s, FPL 2019f

Figure 3-32 Red Mangrove Average Live Biomass Within Two Red Mangrove Plots (M1-2 and M3-2), 2010–2018

FPL's (2018o) 2018 annual monitoring report describes the results of ecological monitoring performed from June 1, 2017, through May 31, 2018. The staff incorporated data from this monitoring report as well as data available on FPL's Electronic Data Management System (FPL 2019f) for the remainder of 2018 (i.e., June 1, 2018, through December 31, 2018) into the above discussion on mangrove monitoring. Data from 2018 support the NRC staff's previous conclusion in the draft supplemental environmental impact statement (DSEIS) that the CCS does not have a discernable ecological impact on the surrounding areas and that there is no clear evidence of CCS water in the surrounding marsh and mangrove areas from a groundwater pathway (FPL 2018o). Overall, mangroves continued to exhibit stable structure and composition during the 2018 reporting period with the exceptions of the recent decreasing trend in biomass in one plot (M1-2).

Tree Island Monitoring

FPL monitors tree island plots semiannually for porewater only. Researchers sample porewater for chloride, sodium, nutrients (nitrogen, ammonia, and phosphorus), and tritium. Section 3.5.1.4, "Adjacent Surface Water Quality and Cooling Canal System Operation," of this

SEIS describes porewater results. FPL's monitoring program has not detected evidence of any impacts from the CCS on soil porewater quality via the groundwater pathway (FPL 2014b, 2016a, 2017a, 2018f, 2018o).

CCS Dewatering

In 2017, the South Florida Water Management District (SFWMD) issued water use Permit No. 13-06251-W, which allows FPL to recover and extract hypersaline water within and around the CCS (SFWMD 2017a). To support this water extraction, called dewatering, FPL began constructing a full-scale recovery well system in June 2017. Dewatering has the potential to impact wetland growth because it removes water from an ecosystem where greater water depth and longer hydroperiods are directly correlated with vegetative growth and species composition (UF undated, Foti et al. 2012). As part of its permitting process, the SFWMD modeled drought conditions (up to a 1-in-10-year drought) and determined that a maximum drawdown of less than 0.3 feet (9.1 cm) of water could occur west and north of the CCS under drought conditions during operation of the wells (SFWMD 2017a). This maximum drawdown limit also applies to onsite and offsite wetlands located west of the CCS. The L-31E Canal would provide some buffering of the drawdown area because the canal stores excess rain water. In issuing the water use permit, the SFWMD (2017a) determined that the risk of adverse effects to wetlands as a result of the authorized withdrawal of the recommended allocation would be minimal.

3.6.3 Wildlife

Southern Florida lies at the southern tip of a temperate landmass, and its subtropical climate supports a wide variety of ecosystems and wildlife, including approximately 350 bird, 50 reptile, 40 mammal, and 15 amphibian species (NPS 2015b). Several tropical species inhabit Florida's mangroves and warm waters, while temperate species migrate south from other areas in the United States. Furthermore, productive wetlands provide a source of refuge and foraging grounds for numerous wildlife and bird species. Section 2.4.1.1 of the NRC staff's EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG-2176) (NRC 2016a) describes wildlife and avian studies conducted at and near Turkey Point in 1972 and from 2005 through 2009. The NRC staff incorporates the above information into this SEIS by reference (NRC 2016a: pages 2-79 to 2-80).

On May 23, 2016, FPL conducted bird and reptile surveys within the vicinity of the Turtle Point remnant canal and Barge-Turning Basin water quality improvement projects. FPL observed one reptile species, the American crocodile (*Crocodylus acutus*), and 6 bird species: common nighthawk (*Chordeiles minor*), brown pelican (*Pelecanus occidentalis*), double-crested cormorant (*Phalacrocorax auritus*), anhinga (*Anhinga anhinga*), mockingbird (*Mimus polyglottis*), and rusty blackbird (*Euphagus carolinus*) (FPL 2016c). The NRC staff (NRC 2016a) previously identified these species as occurring at the Turkey Point site in the EIS for the Turkey Point Units 6 and 7 combined licenses.

From December 5–7, 2016, FPL conducted its CCS characterization study (EAI 2017), which primarily focused on sampling the CCS for fish and invertebrates. FPL also recorded any observations of birds near and within the vicinity of the CCS. In total, FPL documented 13 bird species, many of which used the CCS as a foraging ground for fish during the study. Observed birds included snowy egrets (*Egretta thula*), little blue herons (*Egretta caerulea*), tricolored herons (*Egretta tricolor*), reddish egrets (*Egretta rufescens*), great egrets (*Ardea alba*), roseate spoonbills (*Platalea ajaja*), wood storks (*Mycteria americana*), American white pelicans (*Pelecanus erythrorhynchos*), a yellow-crowned night heron (*Nyctanassa violacea*), a double-crested cormorant, an American avocet (*Recurvirostra americana*), great blue herons (*Ardea herodias*), belted kingfishers (*Megaceryle alcyon*), and ospreys (*Pandion haliaetus*).

The NRC staff also reviewed the Florida Fish and Wildlife Conservation Commission's (FFWCC) Florida Shorebird Database, which is a database of shorebird and seabird occurrences in Florida (FFWCC 2018). The Florida Shorebird Database indicated that a breeding colony of least terns (*Sterna antillarum*), which are listed by the State of Florida as a threatened species in the State, occurs at Turkey Point. Least terns are discussed in further detail in Section 3.7.3.1, "State-Listed Species."

3.6.4 Important Species and Habitats

3.6.4.1 State-Listed Species

In accordance with Chapter 68A-27 of the Florida Administrative Code (FAC), the Florida Fish and Wildlife Conservation Commission oversees the State's Threatened and Endangered Species Conservation Program. This chapter of the FAC gives the FFWCC the authority to list species as State-designated threatened species; to issue regulations necessary and advisable to provide for the conservation of Florida endangered and threatened species, which include federally listed endangered and threatened species and State-designated threatened species; and to prohibit anyone from taking a species, which includes activities that would harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in such conduct. Chapter 5B-40 of the FAC authorizes the Florida Department of Agriculture and Consumer Services to list plants as endangered, threatened, and commercially exploited.

Section 2.4.1.3 and Tables 2-14 and 2-15 of the NRC staff's EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG–2176) (NRC 2016a) describe the State-listed threatened or endangered species that may occur in Miami-Dade County, not including those species that are also federally listed. This information is incorporated here by reference (NRC 2016a: pages 2-97 to 2-109). The NRC staff reviewed the list of State threatened and endangered species within Miami-Dade County that are not federally listed (FNAI 2018) and determined that Tables 2-14 and 2-15 in NUREG-2176 included all listed species as of August 2018, except for the following, which the NRC staff here adds to the list of State-listed threatened or endangered species identified in NUREG-2176. The following species are all State-listed as endangered.

- sea rosemary (*Heliotropium gnaphalodes*)
- Florida shrub thoroughwort (*Koanophyllon villosum*)
- Florida Keys ladies'-tresses (*Mesadenus lucayanus*)
- star-scale fern (*Pleopeltis astrolepis*)
- pineland spurge (*Poinsettia pinetorum*)
- mucha-gente (*Xylosma buxifolia*)

Three additional species, Simpson's prickly apple (*Harrisia simpsonii*), Fahkahatchee ladies'-tresses (*Sacoila lanceolata var. Paludicola*), and Florida black bear (*Ursus americanus floridanus*), were included in NUREG–2176, Tables 2-14 and 2-15. However, these species are not State-listed as endangered or threatened as of August 2018 (FNAI 2018). Florida pine snake (*Pituophis melanoleucus mugitus*), Florida burrowing owl (*Athene cunicularia Floridana*), little blue heron, reddish egret, tricolored heron, American oystercatcher (*Haematopus palliates*), roseate spoonbill, and black skimmer (*Rynchops niger*) were identified as species of special concern in Table 2-15 but are State-listed as threatened as of August 2018. The change in classification of these species therefore modifies the tables of State-listed threatened or endangered species identified in NUREG-2176.

Tables 2-14 and 2-15 in the EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG–2176) also describe whether the species has been observed at the Turkey Point site. Since the NRC staff published NUREG–2176, FPL has conducted two new ecological surveys (FPL 2016c, EAI 2017) as described in Section 3.7.3, "Aquatic Resources on the Turkey Point Site." In its May 23, 2016, survey, FPL (2016c) did not observe any State-listed species other than the American crocodile, which is State-listed as endangered and federally listed as threatened. The crocodile is addressed in Section 3.8.1.2, "Federally Listed Species and Critical Habitats under U.S. Fish and Wildlife Service's Jurisdiction," of this SEIS. Ecological Associates, Inc., (EAI 2017) observed five State-listed species in the 2016 CCS Characterization Study, including wood stork (also federally listed), little blue heron (*Egretta caerulea*), tricolored heron, reddish egret, and roseate spoonbill. These five species had been previously observed at the Turkey Point site, as indicated in NUREG–2176, Table 2-15.

A colony of least terns nest on berms within the CCS (FPL 2018f). The FFWCC's shorebird monitoring program suggests that this colony at the Turkey Point CCS is one of the largest ground-nesting colonies of least terns on the eastern coast of Florida between Key West and Melbourne and that this colony also maintains high rates of nesting success (FFWCC 2016). To minimize disturbances to this nesting colony, FPL installed warning signs surrounding the berms to alert site personnel that least terns are in the vicinity. FPL also limits boat traffic near the colony during nesting season. FPL expects to continue these activities during the subsequent license renewal period of extended operation (FPL 2018g).

3.6.4.2 Migratory Birds

The FWS administers the Migratory Bird Treaty Act (MBTA), which prohibits anyone from taking native migratory birds or their eggs, feathers, or nests. Regulations under the Migratory Bird Treaty Act define "take" as "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to" carry out these activities (Title 50, "Wildlife and Fisheries," of the *Code of Federal Regulations* (50 CFR) 10.12, "Definitions"). The act protects a total of 1,007 migratory bird species (75 FR 9282). The FWS's (2018a) online Information Planning and Consultation System tool identifies 35 migratory birds of concern that may occur on or near the Turkey Point site. Of those 35 migratory bird species, FPL (2018h) identified 11 species that have been observed onsite at Turkey Point. FPL (2018h) also noted that 23 additional bird species protected under the MBTA have been observed onsite, although they were not included in FWS's (FWS 2018a) database list. While FPL has not implemented a formal monitoring or survey program for migratory birds, Table 3-8 describes the birds protected under the MBTA that are most likely to occur at the Turkey Point site based on a combination of the FWS's database list and FPL survey data and incidental observation records. The table also identifies typical use of the Turkey Point site by species (e.g., resting, foraging, and breeding).

The FWS also administers the Bald and Golden Eagle Protection Act of 1940, as amended (16 U.S.C. 668 et seq.), which prohibits anyone from taking bald eagles (*Haliaeetus leucocephalus*) or golden eagles (*Aquila chrysaetos*), including their nests or eggs, without a permit issued by the FWS. The FWS (2018a) determined that bald eagles may occur and breed near the Turkey Point site throughout the year. FPL (2018g) has observed bald eagles using the Turkey Point site for resting, although the species is rarely observed onsite.

Table 3-8 Migratory Birds Protected under the Migratory Bird Treaty Act That Are Most Likely to Occur at Turkey Point

Scientific Name	Common Name	Frequency of Onsite Observations	Onsite Habitat Use
Anhinga	anhinga	occasionally	resting, foraging
Ardea alba	great egret	frequently	resting, foraging
Ardea herodias	great blue heron	frequently	resting, foraging
Bubo virginianus	great horned owl	rarely	resting, foraging, breeding
Bubulcus ibis	cattle egret	frequently	resting, foraging
Butorides virescens	green heron	frequently	resting, foraging, breeding
Charadrius vociferus	killdeer	frequently	resting, foraging, breeding
Chordeiles minor	common nighthawk	frequently	resting, foraging, breeding
Circus hudsonius	northern harrier	frequently	resting, foraging
Crotophaga ani	smooth-billed ani	rarely	resting, foraging
Egretta caerulea	little blue heron	frequently	resting, foraging
Egretta rufescens	reddish egret	frequently	resting, foraging
Egretta thula	snowy egret	frequently	resting, foraging
Egretta tricolor	tri-colored heron	frequently	resting, foraging
Elanoides forticatus	swallow-tailed kite	rarely	resting, foraging
Empidonax sp.	flycatcher	occasionally	resting, foraging
Eudocimus albus	white ibis	frequently	resting, foraging
Falco peregrinus	peregrine falcon	occasionally	resting, foraging
Gavia immer	common loon	rarely	unknown
Haliaeetus leucocephalus	bald eagle	rarely	foraging
Megaceryle alcyon	belted kingfisher	frequently	resting, foraging
Megascops asio	Eastern screech owl	occasionally	resting, foraging, breeding
Melanerpes carolinus	red bellied woodpecker	frequently	resting, foraging, breeding
Mycteria americana	woodstork	occasionally	resting, foraging
Pandion haliaetus	osprey	frequently	resting, foraging
Patagioenas leucocephala	white-crowned pigeon	frequently	resting, foraging
Pelecanus erythrorhynchos	American white pelican	frequently	resting, foraging
Pelecanus occidentalis	brown pelican	occasionally	resting, foraging
Phalacrocorax auritus	double-crested cormorant	frequently	resting, foraging
Platalea ajaja	roseate spoonbill	frequently	resting, foraging
Sterna antillarum	least tern	frequently	resting, foraging, breeding
Thalasseus maximus	royal tern	frequently	resting, foraging
Tringa flavipes	lesser yellowlegs	occasionally	resting, foraging
Tyrannus dominicensis	grey kingbird	frequently	resting, foraging

Source: FWS 2018a; FPL 2018h

Many other migratory birds occur in the region. For instance, the National Park Service (NPS 2017b) reports 213 bird species from Biscayne National Park. In comments on the NRC's draft SEIS, the National Park Service (NPS 2019b) stated that in addition to the species identified in the table above, the following migratory birds are also likely to occur on or near the Turkey Point site: Northern mockingbird (*Mimus polyglottos*), blue jay (*Cyanocitta cristata*), Northern cardinal (*Cardinalis cardinalis*), mangrove cuckoo (*Coccyzus minor*), yellow-billed cuckoo (*Coccyzus americanus*), black-bellied plover (*Pluvialis squatarola*), red knot (*Caladris rufa*), whimbrel (*Numanius phaeopus*), Western sandpiper (*Calidris maurii*), least sandpiper (*Calidris minutilla*), laughing gull (*Larus atricilla*), ring-billed gull (*Larus delawarensis*), great black-backed gull (*Larus marinus*), lesser black-backed gull (*Larus fuscus*), downy woodpecker (*Dryobates pubescens*), black-and-white warbler (*Mniotilta varia*), American redstart (*Setophaga ruticilla*) and black-throated blue warbler (*Setophaga caerulescens*). FPL (2014a; Table 2.4-1) reported observing many of these species during avifauna surveys in connection with Turkey Point Units 6 and 7, which included the Turkey Point property as well as existing and proposed transmission line corridors. Although lack of observation does not preclude species' occurrence, FPL (2014a, 2018f, 2018h) has not observed blue jays, ring-belled gull, great or black-backed gull, downy woodpecker, black-and-white warbler, or black-throated blue warbler on the Turkey Point site. The red knot, a federally listed species, is addressed in Section 3.8.1.2, "Federally Listed Species and Critical Habitats under U.S. Fish and Wildlife Service's Jurisdiction," of the SEIS.

3.6.4.3 Important Habitats

Sections 2.2.1.6, 2.4.1.2, and 2.4.1.3 of the NRC staff's EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG–2176) (NRC 2016a) describe several important terrestrial restoration efforts and habitats located within National Parks, preserves, and other federally owned, State-owned, County-owned, and privately-owned land. These include the following:

- Biscayne National Park, which provides mangrove and other important habitat to wildlife and over 200 species of birds, 21 of which are Federally listed as threatened or endangered (NPS 2018a) (see pages 2-10 and 2-79 to 2-80 in NUREG–2176 (NRC 2016a)).
- Everglades National Park, which encompasses approximately 1.5 million ac (607,000 ha) of wetlands, open water, and other important habitats for a variety of wildlife and birds (see pages 2-11, 2-80, and 2-110 in NUREG–2176 (NRC 2016a)).
- The Comprehensive Everglades Restoration Plan (CERP) was approved by Congress in 2000 to restore, preserve, and protect the south Florida wetlands ecosystem while providing for other water-related needs of the region. The area covered by this plan includes the entire Everglades ecosystem. This interagency effort is one of the largest ecosystem restoration efforts in the country and includes multiple smaller efforts, such as the Biscayne Bay Coast Wetlands project (NPS 2018a; sees page 2-11 and 2-80 in NUREG–2176 (NRC 2016a)).
- South Dade Wetlands Project, also referred to as Model Lands, which is co-managed by Miami-Dade County's Department of Environmental Resources and the Southwest Florida Water Management System. These areas include over 20,000 ac (8,000 ha) of publicly owned conservation lands, including Miami-Dade County Environmentally Endangered Lands (DERM 2018). These wetlands serve as habitat and refuge for a variety of wildlife, including numerous federally listed and State-listed threatened and endangered species (see pages 2-10 and 2-133 in NUREG–2176 (NRC 2016a)).

- Everglades Mitigation Bank, which is a 13,000 ac (5,300 ha) expanse of freshwater and estuarine wetlands west and south of the Turkey Point CCS. FPL owns the Everglades Mitigation Bank and operates it as a commercial mitigation bank offering wetland habitat credits that can be purchased to offset regional wetland impacts (see pages 2-12 and 2-133 in NUREG–2176 (NRC 2016a)).

Additionally, the Audubon Society recognizes the Biscayne Bay region encompassing all areas off the coast of Miami-Dade County stretching east of North Miami Beach to southeast of Homestead as an Important Bird Area (Audubon 2019). The Audubon recognizes this area's ornithological significance because it supports many Neotropical migrant species, significant populations of federally listed and other special concern species, and a colonial waterbird rookery.

The NRC staff's EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG–2176) (NRC 2016a) identifies other important habitats that occur within the vicinity of the Turkey Point site, such as mangrove forests (pages 2-109 to 2-110), pine rockland (page 2-110), marl prairie (page 2-110), and wetlands (page 2-110). The NRC staff incorporates this information from NUREG–2176 into this SEIS by reference (NRC 2016a: pages 2-109 to 2-110). Federally listed and State-listed threatened or endangered species that have the potential to occur within these important terrestrial habitats are described in pages 2-84 through 2-109 of NUREG–2176 (NRC 2016a), which information is also incorporated by reference herein.

3.6.5 Invasive and Non-Native Species

Several invasive and non-native species occur at Turkey Point. Although FPL does not formally record the occurrence of such species, common invasive species on the Turkey Point site include Australian pine (Casuarina equisetifolia), beach naupaka (*Scaevola sericea*), Brazilian pepper (*Schinus terebinthifolius*), Burma reed (*Neyraudia reynaudiana*), and melaleuca (*Melaleuca quinquenervia*) (FPL 2018f). The Argentine black-and-white tegu (*Tupanimbis merianae*) and Burmese python (Python molurus ssp. bivittatus) have also been observed at Turkey Point (FPL 2018f). The invasive Argentine black-and-white tegu, an egg-eating lizard, is an omnivore with the potential to affect many species, including alligators and crocodiles, and is the subject of a multiagency control effort in the immediate vicinity of the Turkey Point site. The invasive Burmese python is a nonvenomous constrictor whose predation threatens a wide range of native wildlife, including songbirds, deer, and alligators. As described in Section 4.6.1.1, FPL (2018f) maintains a program to remove invasive species from the CCS on an annual basis.

3.7 <u>Aquatic Resources</u>

This section describes the aquatic resources of the affected environment, including the Southern Florida Coastal Plain Ecoregion, the CCS, Biscayne Bay, and Card Sound.

3.7.1 Southern Florida Coastal Plain Ecoregion

The Turkey Point site is located within the Southern Florida Coastal Plain ecoregion. This ecoregion is characterized by a hydrologically interconnected, slow-flowing network of wetland and aquatic systems, including ridge and slough landscapes, sawgrass plains, cypress and mangrove swamps, and coastal lagoons and bays. The Everglades, a subtropical wetland ecosystem that hosts a rich diversity of aquatic habitats and plant and animal species, comprise much of the ecoregion. The Florida Keys, barrier islands that extend along the extreme southern coast of the Florida Peninsula, protect estuarine bays and coves from the Atlantic

Ocean and create important spawning habitats. The Southern Florida Coastal Plain ecoregion is also known for the Florida reef, the only living coral reef tract in the continental United States.

Beginning in the early 1900s, the hydrology of the ecoregion has been highly altered by human activity to support agricultural and urban development. In 1948, Congress authorized the creation of the Central and Southern Florida Flood Control Project, one of the largest water management systems in the world. Through this project, a series of canals were created across Southern Florida to drain the land for flood control, water supply and retention, irrigation, and transportation. Subsequent land drainage resulted in the loss or conversion of a substantial portion of the original wetland system, reduced sheet flow dramatically, and created point-source discharge of freshwater into estuarine waters and coastal wetlands. The coastal areas of the ecoregion have also become highly populated and dense beachfront development is common. Nevertheless, a large portion of the ecoregion remains protected at the county, State, or Federal level and is managed to maintain and restore the region's unique and sensitive habitats. Section 2.4.2, "Aquatic Ecology," of the NRC staff's EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG-2176) (NRC 2016a) provides more detailed information on the Southern Florida Coastal Plain ecoregion, including anthropogenic alterations and other past changes to the environment. The NRC staff incorporates the NUREG-2176 descriptions of the ecoregion into this SEIS by reference.

3.7.2 Aquatic Resources near the Turkey Point Site

The region surrounding Turkey Point contains shallow subtropical estuarine and marine environments, including Biscayne Bay and its associated park and preserve; Florida Keys National Marine Sanctuary; Card Sound and Canal; the Everglades Mitigation Bank, Model Lands Basin, and Southern Glades Addition; as well as Everglades National Park and the Crocodile Lake National Wildlife Refuge.

Biscayne Bay is a shallow subtropical saline lagoon that extends the length of Miami-Dade County. A series of barrier islands belonging to the Florida Keys borders the eastern edge of the bay and separates the bay from the Atlantic Ocean. The mainland forms the western and northern borders of the bay. Connection between Biscayne Bay and the Atlantic Ocean is greatest north of Boca Chita Key. Ocean access is most restricted in the southern portion of the bay at Card Sound and Barnes Sound due to the presence of Key Largo and its associated barrier islands. The average depth of the bay is approximately 5 ft (1.5 m) at mean low water, and its maximum depth is approximately 13 ft (4.0 m). Salinity is highly influenced by rainfall and ranges from 24 to 44 PSU. Annual surface water temperatures range from 59 °F to 92 °F (15 °C to 33 °C). The bay's shallow depths and low spring tidal range (3 ft (0.9 m) maximum) result in a vertically well-mixed system with weak stratification.

Within the bay, Biscayne National Park encompasses 173,000 ac (70,000 ha) of water and coastal lands as well as 42 islands. The park is home to a large segment of the Florida reef, the only living coral reef tract in the continental United States. The park supports an immense array of wildlife, including more than 600 fish species, many of which are commercially and recreationally important, and 21 federally threatened or endangered species. Notably, the bay provides habitat for the federally listed Florida manatee (*Trichechus manatus latirostris*) (a subspecies of the West Indian manatee (*T. manatus*)), smalltooth sawfish (*Pristis pectinata*), American crocodile, and Johnson's seagrass (*Halophila johnsonii*) (FDEP 2017b). Johnson's seagrass is the first and only marine plant to be listed as threatened under the Endangered Species Act.

The Biscayne Bay Aquatic Preserve includes 67,000 ac (27,000 ha) of sovereign submerged lands managed by the FDEP's Office of Coastal and Aquatic Managed Areas. The preserve runs the length of Biscayne Bay from the headwaters of the Oleta River down to Card Sound near Key Largo. The FDEP designated the waters within the Biscayne Bay Aquatic Preserve as Outstanding Florida Waters for waters worthy of special protection because of natural attributes. Under the Outstanding Florida Waters designation, the State cannot issue permits for direct discharges that would lower ambient water quality (FDEP 2017a).

Card Sound is a shallow bay south of the Turkey Point site with limited connection to the Atlantic Ocean. It lies wholly within the boundary of the Florida Keys National Marine Sanctuary. The mangrove forests surrounding Card Sound are part of the longest continuous stretch of mangrove remaining on the east coast of Florida and provide a source of food and refuge for approximately 70 percent of the region's commercially and recreationally important marine species. Both Biscayne Bay and Card Sound are nursery areas for the spiny lobster (*Panulirus argus*). The State of Florida has designated the area from Cape Florida near Key Biscayne south to Card Sound as the Biscayne Bay-Card Sound Lobster Sanctuary.

Section 2.4.2 of the NRC staff's EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG–2176) (NRC 2016a) describes Biscayne Bay, Card Sound, and other nearby aquatic resources in detail. The NRC staff incorporates those descriptions from NUREG–2176 into this SEIS by reference. In addition, see Section 3.7.4 of this SEIS for a detailed discussion of FPL's semiannual monitoring of Biscayne Bay and Card Sound.

3.7.3 Aquatic Resources on the Turkey Point Site

Within the Turkey Point site, the primary aquatic environment is the cooling canal system (CCS). The CCS occupies an area that is approximately 2 mi (3.2 km) wide by 5 mi (8 km) long and includes 168 mi (270 km) of earthen canals that cover an effective water surface area of approximately of 4,370 ac (1,770 ha) and a total surface area of 5,900 ac (24 km^2) (FPL 2018f, NRC 2002c). The CCS's channels are about 200 feet (60 m) wide and range in depth from 1 to 3 feet (0.3 to 1 m) (FPL 2018f). FPL constructed the CCS to use as an industrial wastewater facility. For a description of the CCS operations, see Section 3.1.3, "Cooling and Auxiliary Water Systems," in this SEIS.

The CCS has historically supported a variety of fish, mollusks, crabs, and submerged aquatic vegetation that are tolerant of shallow, subtropical, hypersaline environments such as sheepshead minnow (*Cyprinodon variegatus*) and several *Fundulus* species. FPL (2014a) reported that the species identified in Table 3-9 were present in the CCS as of November 2007. Because the CCS does not directly connect to any surface water body, aquatic organisms are unable to travel between the CCS and any other water bodies. Aquatic biota in the CCS are not accessible for recreational or commercial harvest because FPL controls the entirety of the CCS and does not allow the public to access it.

Table 3-9 Aquatic Species Reported from the Cooling Canal System, November 2007

Species	Common Name
Fish	
Centropomus undecimalis	common snook
Cyprinodon variegatus	sheepshead minnow
Fundulus spp.	killifish

Species	Common Name
Gambusia spp.	mosquitofish
Megalops atlanticus	tarpon
Mugil spp.	mullet
Poecilia latipinna	sailfin molly
Strongylura spp.	needlefish
Mollusks	
Busycon contrarium	lightning whelk
Cerithium eburneum	ivory cerith
Isognomon alatus	flat tree oyster
Isognomon radiatus	Lister's tree oyster
Marisa cornuarietis	giant rams horm
Melampus bidentatus	eastern melamphus
Melongena corona	Florida crown conch
Tellin spp.	tellin
Crustaceans	
Cardisoma guanhumi	great land crab
Uca spp.	fiddler crab
Submerged Aquatic Vegetation	
Acetabularia spp.	mermaid's wineglass (green algae)
Batophora spp.	green algae
Caulerpa spp.	green algae
Ruppia maritima	widgeon grass
Source: adapted from FPL 2014a	

Other onsite aquatic resources at Turkey Point include hypersaline mudflats, remnant canals, channels, dwarf mangrove wetlands, and open water. In June 2009, Tetra Tech NUS, Inc. (Tetra Tech 2009) conducted fish surveys throughout the Turkey Point property in both CCS and non-CCS waters. Sampling locations, which are depicted in Figure 3-33, included:

- mangrove wetland west of Turkey Point (TP-1)
- sawgrass marsh/mangrove community adjacent to Palm Drive (TP-2)
- south (TP-3A) and north (TP-3B) remnant canals
- a portion of the return canal (TP-4)
- shallow flats in the east-central part of the Turkey Point plant area (TP-5)
- a dead-end canal (TP-6)
- CCS north (TP-7)
- CCS south (TP-8)

During sampling, water temperatures ranged from 75.0 to 97.7 °F (23.9 to 36.5 °C), salinity was above 50 PSU at six sampling stations (TP-3A, TP-4, TP-5, TP-6, TP-7, and TP-8), and salinity was less than or equal to 1.5 PSU at two stations in sawgrass/mangrove habitats (TP-1 and TP-2) (Tetra Tech 2009). Tetra Tech biologists collected fish with 8-foot (2.4-m) cast nets, a 20-ft (6-m) -long minnow seine, and standard "Gee"-type galvanized minnow traps. Sampling yielded a total of 433 fish representing seven species. All but one of the fish collected were small-bodied, short-lived, schooling species representative of two families: the killifishes (family Cyprinodontidae) and the livebearers (family Poeciliidae). Sheepshead minnow was the dominant species; this fish species was present in seven of the eight sampling stations and represented 63 percent of the collection. Sailfin molly (*Poecilia latipinna*) and goldspotted killifish (*Floridichthys carpio*) were present at most of the sampling stations and represented 20.8 percent and 9.9 percent of collections, respectively. No fish were collected at TP-2, a sawgrass marsh/mangrove community adjacent to Palm Drive. All fish were of hardy species common to South Florida; no rare, unusual, sensitive, or protected species were present in collections. Table 3-10 identifies the collected species, relative abundances, and collection locations.

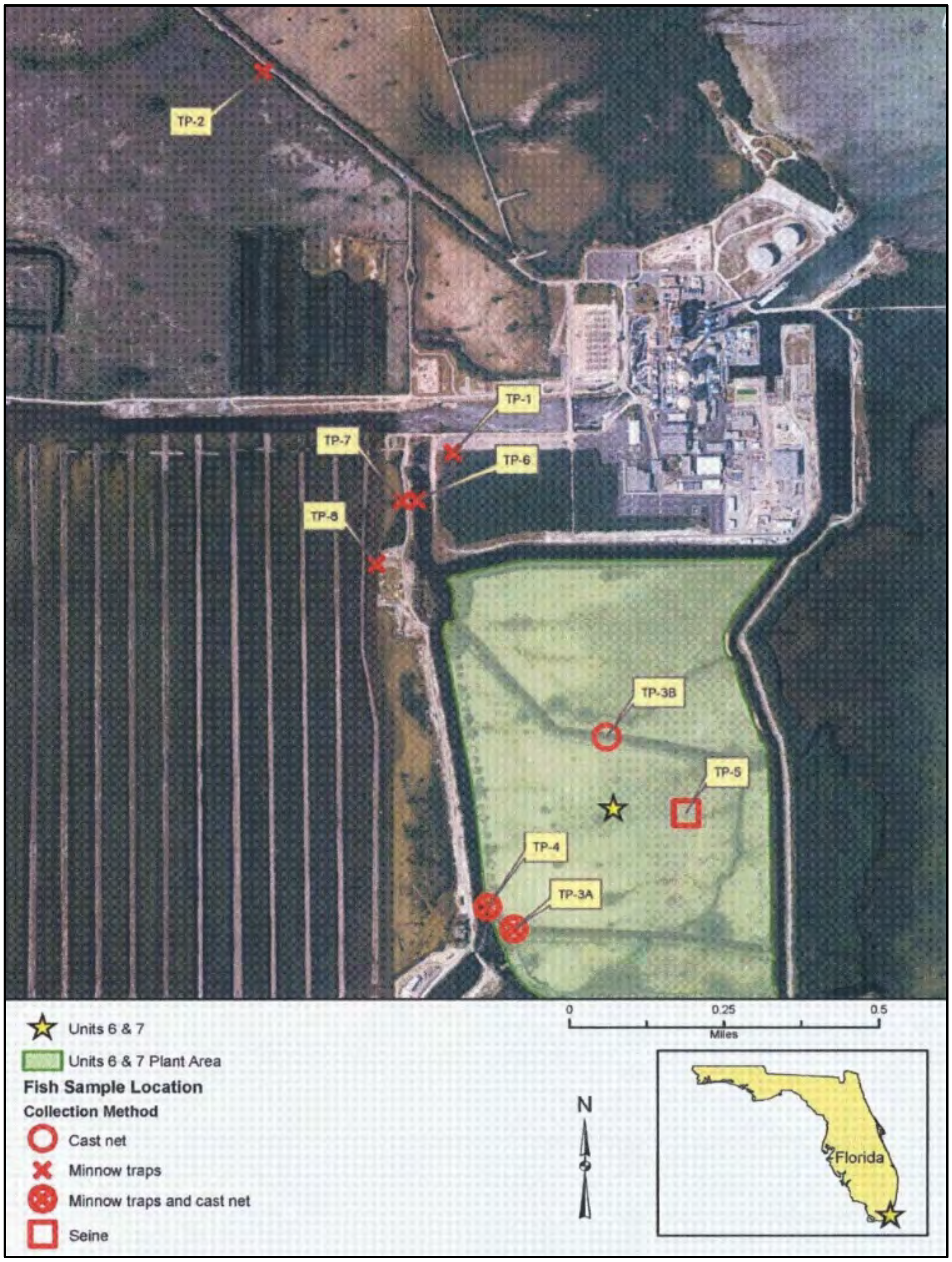
Table 3-10 Number and Relative Abundance of Fish Captured at Seven Locations on the Turkey Point Site, June 2009

Species	Common Name	Number Collected	Collection Locations
Cyprinodon variegatus	sheepshead minnow	273	all locations except TP-2
Poecilia latipinna	sailfin molly	90	all locations except TP-2, TP-5
Floridichthys carpio	goldspotted killifish	43	all locations except TP-1, TP-2
Fundulus confluentus	marsh killifish	15	TP-1
Fundulus grandis	gulf killifish	6	TP-1, TP-3, TP-7, TP-8
Gambusia affinis	mosquitofish	5	TP-1, TP-4
Opsanus beta	gulf toadfish	1	TP-4

Source: Tetra Tech 2009

Prior to 2010, the CCS environment was of low turbidity and contained low and stable nutrient levels. Widgeon grass (*Ruppia maritima*) beds covered over 50 percent of the system and were especially prominent in the southern sections of the CCS and in the eastern return canals. Seagrasses underwent annual periods of stress and recovery as CCS salinities cycled between greater than 50 PSU (stress) and less than 50 PSU (recovery). Despite the harsh environment, seagrass colonies remained relatively stable from year to year (FPL 2016k).

In 2010, the CCS began experiencing a pronounced ecosystem shift. The average salinity of the CCS increased, water quality and clarity began to degrade, and average surface water temperatures increased. Seagrass colonies began to die off due to salinity- and high temperature-related stress. By 2012, very few seagrass beds remained in the CCS. The subsequent decomposition of the seagrasses released a significant volume of nutrients into the CCS, and the increased nutrient levels facilitated algae blooms, which resulted in high turbidity and degraded water quality. Algae blooms remained local and isolated in 2011 and 2012. In 2013 and 2014, continuously elevated concentrations of algae were observed throughout the CCS. By 2016, no seagrasses remained in the CCS. The CCS currently operates as an algal-based, phosphorus-limited system such that the algae life cycle primarily dictates the movement of nutrients in and out of the water column (FPL 2016k).



Source: Tetra Tech 2009, Figure 1

Figure 3-33 Turkey Point Site Fish Survey Sample Locations, June 2009

To address CCS water quality degradation and as a requirement of the 2016 FDEP Consent Order, FPL began implementing a Nutrient Management Plan (FPL 2016k) in 2016. The plan includes short- and long-term initiatives. One initiative is to reestablish seagrass meadows within the CCS. FPL (2016k) states in its plan that a healthy seagrass population of approximately 50 percent of the surface water acreage would help balance and sequester the CCS's nutrient content. Seagrasses require non-turbid, clear water with near-ocean salinity levels (roughly 30 to 37 PSU). Given the current turbid, hypersaline, and phosphorus-limited conditions in the CCS, FPL is concentrating its efforts on removing or binding bioavailable phosphorus to reduce algae growth, which would in turn reduce nitrogen fixation, increase water clarity, and improve the conditions for re-establishment of seagrasses. FPL is currently investigating the direct application of flocculants into the CCS, treatment of CCS water in an external system, and the use of protein skimming methods to actively remove algae and nutrients. Once FPL reduces nutrients and lowers salinities, FPL will cultivate and plant seagrass beds within areas of the CCS with appropriate depth and substrate. As CCS conditions improve, some dormant seagrass seeds in the CCS may also germinate such that seagrasses may reemerge naturally. Once re-established, a healthy seagrass population will provide a significant mechanism for uptake and retention of nutrients, thus reducing nutrient concentrations in the water. Lower nutrient concentrations in the water will deter algal blooms and fewer algal blooms will lead to greater water clarity. FPL's Nutrient Management Plan sets a seagrass colonization target at 50 percent of the CCS water acreage. Section 3.5.1.4 describes the plan in more detail under the subsection titled, "Nutrient Management Plan for the Cooling Canal System."

In September 2018, FPL (2018r) implemented a field scale pilot test planting of widgeon grass at separate locations within the CCS to determine whether the system can support seagrass under current conditions. This species was selected due to its high salinity tolerance and because it was historically the dominant species of seagrass in the CCS. FPL pre-conditioned pilot plants to withstand high salinity and then mechanically planted them in the CCS. Prior to this planting, FPL had successfully completed several smaller scale plantings in the CCS and in test tanks. Based on the results of the pilot planting, FPL will consider additional test plantings.

To determine the presence, relative abundance, and distribution of fish, invertebrate, and seagrass populations currently within the CCS, FPL commissioned Ecological Associates, Inc. (EAI) to conduct a biological characterization study in December 2016 (EAI 2017). EAI established ten sampling stations within the CCS chosen to represent different benthic habitats, salinity gradients, and temperature regimes (see Figure 3-34). Seven stations were in the main CCS area, two were located in return canals, and one was located in a dead-end canal in the northern section of the system. EAI sampled fish and mobile invertebrates, benthic macroinvertebrates, and submerged aquatic vegetation.

To identify fish and mobile invertebrates, EAI performed cast net sampling on December 5, 2016, and minnow trap sampling on December 6 and 7, 2016. Cast net sampling targets large mobile organisms throughout the water column, while minnow trap sampling selectively targets small species at the top and bottom of the water column. EAI collected a total of 4,843 individuals of 4 taxa: sheepshead minnow, sailfin molly, eastern mosquitofish (*Gambusia holbrooki*), and mudflat fiddler crabs (*Uca rapax*). Cast net samples yielded 282 fish: 259 sheepshead minnow, 22 sailfin molly, and 1 eastern mosquitofish. All fish collected during cast netting were small (less than 45 mm (1.75 inch) standard length). Minnow traps yielded 4,547 fish and 14 crabs: 3,900 sheepshead minnow, 627 sailfin mollies, 20 eastern mosquitofish, and 14 mudflat fiddler crabs. Fish ranged from 10 to 60 mm (0.4 to 2.4 inch) standard length, and crabs ranged from 8 to 11 mm (0.3 to 0.43 inch) carapace length and 11 to 15 mm (0.43 to 0.59 inch) carapace width.

Source: EAI 2017, Figure 1

Figure 3-34 Cooling Canal System Characterization Survey Sample Locations, December 2016

Sheepshead minnow were abundant throughout the CCS and were found at all 10 sampling stations during the CCS characterization study. This species can live and successfully reproduce in high salinity waters (up to 147 PSU) and high temperatures (up to 109.4 °F (43 °C)) (Johnson 1974). Sailfin mollies were moderately abundant throughout the system. This species is also able to tolerate high salinities (up to 80 PSU), high temperatures (up to 104 °F (40 °C)), and low dissolved oxygen (Fischer and Schlupp 2009, Nordlie et al. 1992, Timmerman and Chapman 2004). Eastern mosquitofish were only found at 2 of the 10 sampling stations and are likely rare in the CCS as a whole. This species can also tolerate high temperatures (up to 100.4 °F (38 °C)), hypersaline (up to 58.8 PSU) waters with low dissolved oxygen (Chervinski 1983, Specziar 2004). Mudflat fiddler crabs were captured incidentally with sampling methods not designed to capture crabs, so EAI (2017) did not make any conclusions regarding crab abundance in its CCS characterization study report. Nevertheless, mudflat fiddler crabs have also been documented as able to withstand high temperature, high salinity, and low dissolved oxygen conditions (Costa and Soares-Gomes 2015, Vernberg and Tashian 1959, Zanders and Rojas 1996). Meroplankton sampling would be required to conclusively determine whether mudflat fiddler crabs are actively reproducing in the CCS or whether individuals were present due to recruitment by immigration into the system. EAI (2017) found no evidence that the environmental conditions within the CCS were negatively affecting the growth or reproduction of the species captured, all of which tended to be heat- and salinity-tolerant species.

To identify benthic macroinvertebrates, EAI (2017) collected benthic mini-ponar grabs on December 6, 2016, which EAI subsequently processed in a laboratory. A total of 79 individuals of 3 taxa were identified. The polychaete *Capitella capitate* was the most common taxon collected followed by marine oligochaetes (Class Oligochaeta) and midge larvae (Family Chironomidae). EAI calculated benthic macroinvertebrate densities to range from 30 to 489 individuals per square meter at stations with organisms present. Evidence of relic gastropod and bivalve shells were also present at some stations; however, no live mollusk specimens were collected.

In addition to fish and benthic sampling, EAI (2017) used underwater video on December 5 and 6, 2016, along defined video transect surveys to search for living submerged aquatic vegetation (seagrasses). Widgeon grass, which was previously the predominant submerged aquatic vegetation type present in the CCS, can grow in waters ranging from 64.4 to 86 °F (18 to 30 °C), although temperatures above 73.4 to 77 °F (23 to 25 °C) have a negative influence on photosynthesis (Arnold et al. 2017). One study on the effect of salinity on the species determined that 8- to 12-week old plants could not tolerate salinities above 21,000 parts per million (ppm) (Mayer and Low 1970). This equates to approximately 21 PSU. During the CCS characterization study, EAI observed no seagrasses. Because water clarity was poor throughout the entire project area, EAI also scanned its benthic macroinvertebrate collections for living vegetation. No samples contained living vegetation. In its report, EAI attributed the lack of submerged aquatic vegetation to the CCS's turbid water conditions, high salinity, and high temperatures.

While differences in sampling methods and effort make definitive conclusions difficult to determine, the available information on the CCS aquatic community indicates that species diversity within the system has declined over time. Submerged aquatic vegetation is no longer present in the system, and many fish species reported as present in the system in 2007 and 2009 were not collected in 2016. The current aquatic community is of low diversity and includes only those species that can withstand hot, hypersaline waters with low dissolved oxygen and poor water clarity.

3.7.4 Biscayne Bay and Card Sound Semiannual Monitoring

Since September 2010, FPL has commissioned ongoing, semiannual ecological monitoring of the Turkey Point site and surrounding environment, including Biscayne Bay, as a requirement of the FDEP's Conditions of Certification in connection with the Turkey Point extended power uprate and the SFWMD's Fifth Supplemental Agreement. Ecology & Environment, Inc. conducted the most recently reported period of monitoring for Biscayne Bay in September 2017 and May 2018 (one fall and one spring event). Ecology & Environment, Inc. summarized and compared the results of this monitoring period with corresponding past results during the historical period of record. The results appear in the 2018 Turkey Point Plant Annual Monitoring Report (FPL 2018o). This section briefly summarizes the monitoring methods and the 2016-2017 results.

FPL performs aquatic ecological sampling in three locations adjacent to the CCS within Biscayne Bay and Card Sound (BB1, BB2, and BB3) and one reference site in Barnes Sound (BB4), which lies directly south of Card Sound (see Figure 3-35). Within each of the study areas, ecological conditions are monitored along two 2-km (1.2-mi)-long shore-parallel transects (designated “a” and “b” for each study area) that lie approximately 250 and 500 m (0.16 and 0.32 mi) from shore. Each transect is divided into eight 250-m (0.16-mi)-long segments. Researchers randomly selected a 1-m^2 (0.6-mi^2) point along each of the eight segments during the initial September 2010 sampling event to be used as the permanent location for all future sampling events. Thus, ecological monitoring encompasses a total of 16 sampling points per study area and a total of 64 sampling points across all study areas. This sampling design is based on FPL’s State-approved monitoring plan (SFWMD 2009).

At each sampling location, submerged aquatic vegetation is surveyed and categorized according to the Braun-Blanquet Cover Abundance Index. Sediment depth and general physical and surface water parameters are collected. Turtle grass (*Thalassia testudinum*) blades are collected for laboratory nutrient analysis. In addition to quantitative data, divers also record qualitative characteristics of the benthic conditions surrounding each sampling point.

In the 2018 report, ecological monitoring findings were similar to those reported in previous annual monitoring reports. Ecology and Environment Inc.’s major findings were as follows (FPL 2018o).

- The marsh and mangrove areas are representative of the hydrologically modified or nutrient-limited communities found along the coastal fringe of south Florida.
- Data collected during the reporting period continue to support the conclusion that the CCS does not have an ecological impact on the surrounding areas, and there is no clear evidence of CCS water in the surrounding marsh or mangrove areas from a groundwater pathway. Rather, ecological changes observed during the reporting period are more seasonally and meteorologically driven.

The remaining subsections within this section provide additional information on FPL’s Biscayne Bay submerged aquatic vegetation monitoring data, trends, and results that led to the two bulleted conclusions above. Section 3.6.2, “Marsh, Mangrove, and Tree Island Semiannual Monitoring,” of this SEIS describes the results of marsh and mangrove monitoring surrounding the Turkey Point site. Section 3.5.1.4, “Adjacent Surface Water Quality and Cooling Canal System Operation,” describes Biscayne Bay surface water quality monitoring results.

Submerged Aquatic Vegetation Monitoring

Submerged aquatic vegetation includes rooted vascular plants that grow up to the water surface but not above it. In estuarine and marine waters, seagrass is the primary type of submerged aquatic vegetation. Seagrass is an important component of estuarine systems like Biscayne Bay because it provides habitat, shelter, and food for fish, shellfish, sea turtles, marine mammals, and other aquatic organisms. Seagrass adds dissolved oxygen to the water through photosynthesis, and its leaves and roots help to stabilize the shoreline against erosion and protect it from storm surges. Seagrass also absorbs nutrients, which remain locked in plant biomass throughout the spring and summer; in the fall, as the plants die and then decay, they release nutrients back into the water when phytoplankton blooms are less of a concern. The EPA (2006) recognizes seagrass and other submerged aquatic vegetation as the hallmark of a healthy estuary.

Turtle grass, a dominant seagrass species in tropical and sub-tropical coastal waters, is generally the most abundant seagrass in Biscayne Bay. Due it its shallow depths, Biscayne Bay exhibits high seagrass cover and low-standing seagrass crop (FPL 2018o). Turtle grass can only effectively colonize areas with sufficient substrate depth for its roots to establish and gather nutrients. Higher salinity levels favor turtle grass and shoal grass (*Halodule wrightii*) (Lirman et al. 2014). Generally, when a seagrass bed experiences increased nutrient inputs, the system will first exhibit increased density of existing species followed by shifts in species composition followed by loss of seagrasses as nutrient inputs continue over time (Fourqurean et al. 1995) (see the subsection below titled, “Seagrass Leaf Nutrient Analysis” for more information on seagrass bed responses to ecological change).

FPL samples Biscayne Bay and Card Sound seagrasses biannually to monitor changes in cover and faunal composition over time and with distance from the CCS. Researchers collect samples at the established test (BB-1, BB-2, and BB-3) and reference (BB-4) locations (see Figure 3-35) at the beginning (April-May) and end (September-October) of the seagrass growing season. Researchers collect samples from a total of 32 points (8 points within two transects for each of the four sample locations). Researchers score percent cover at each sampling location according to the Braun-Blanquet Cover Abundance Index. Researchers also measure sediment depth within each scored quadrant and qualitatively assess ecological conditions surrounding each sampling point for the following:

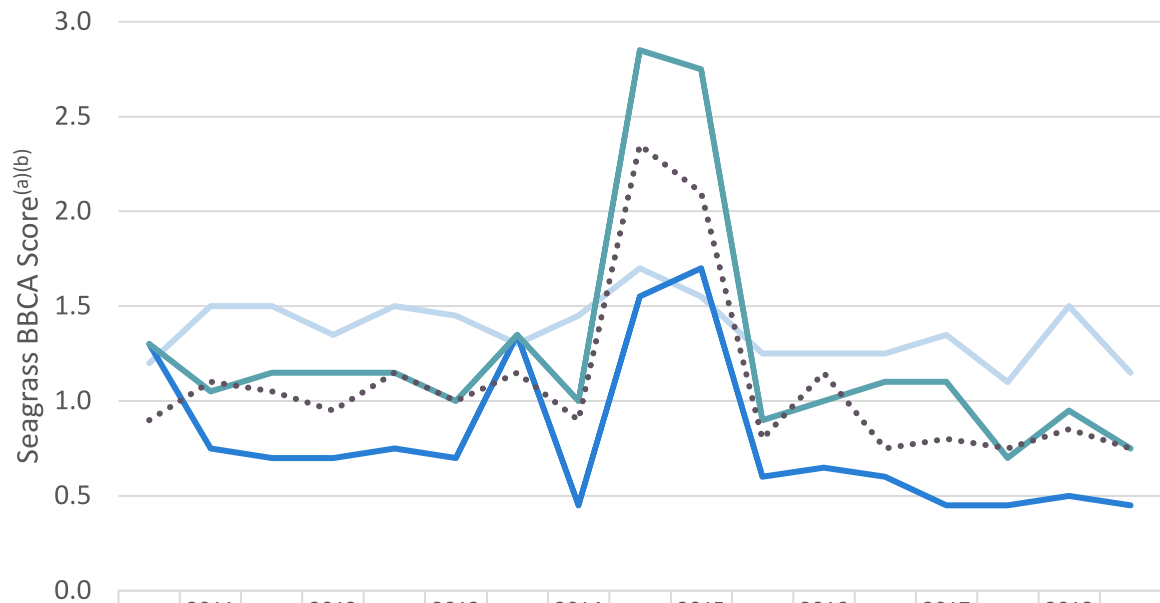
- overall conditions (open, fairly open, moderately open, mostly covered, or uniform)
- presence or absence of seagrass, green algae (*Bataphora* spp.), and drift algae (sparse, sparse to moderate, or moderate to dense)
- amount of calcareous algae, sponges, and hard and soft corals (none, few, or many)
- substrate type (sandy, shell hash, silty, or rubble)

Finally, researchers collect turtle grass blades at two sample points along each transect and process them in a laboratory for nutrient analysis.

Source: E&E 2017, Figure 1.3-1

Figure 3-35 Biscayne Bay and Card Sound Semiannual Monitoring Ecological Transect Locations

Braun-Blanquet Cover Abundance scores are semi-quantitative. Each score represents a range in percent vegetative coverage (i.e., 1 = less than 5 percent, 2 = 5 percent to 25 percent, 3 = 25 percent to 50 percent, 4 = 50 percent to 75 percent, and 5 = greater than 75 percent). Thus, this metric is designed to provide a snapshot of the relative vegetative coverage present in a given area. Within Biscayne Bay, researchers choose random quadrants around sampling points, and thus, some natural variation in numbers is expected due to the patchy nature of submerged aquatic vegetation within the study area. Seagrass coverage is generally expected to exhibit seasonal fluctuations such that coverage is greater in the fall (the end of the seagrass growing season) than in the spring (the end of the quiescent period). However, because the Braun-Blanquet Cover Abundance scores encompass a large range in percent coverage, growth or increased seagrass coverage between sampling events might not always be reflected by a higher score (i.e., a doubling of coverage from 10 percent to 20 percent would not change the coverage score of 2, which represents 5-25 percent coverage).



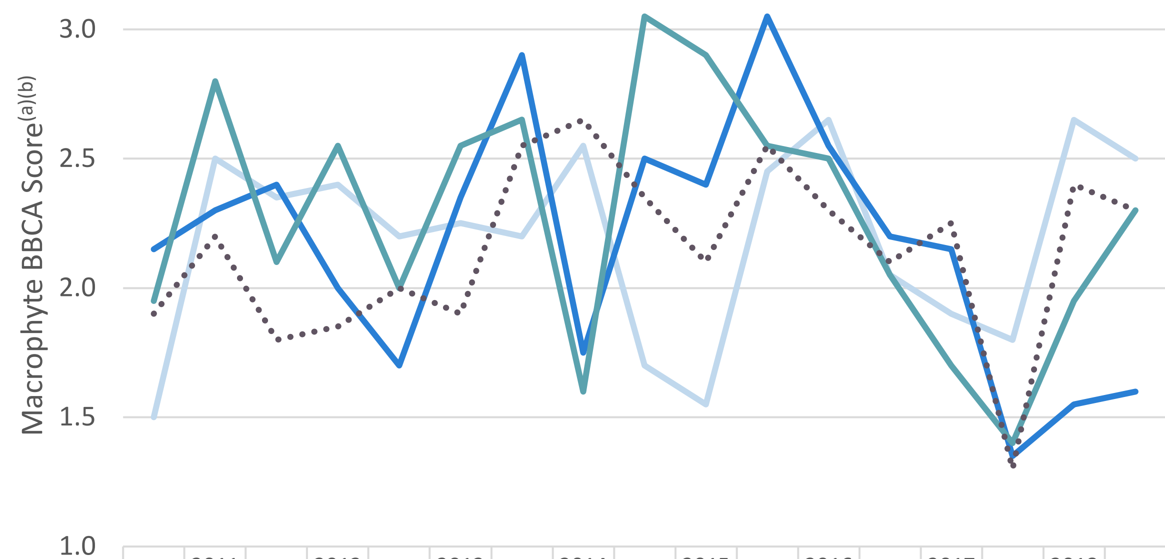
		2011		2012		2013		2014		2015		2016		2017		2018	
BB1	1.2	1.5	1.5	1.4	1.5	1.5	1.3	1.5	1.7	1.6	1.3	1.3	1.3	1.4	1.1	1.5	1.2
BB2	1.3	0.8	0.7	0.7	0.8	0.7	1.4	0.5	1.6	1.7	0.6	0.7	0.6	0.5	0.5	0.5	0.5
BB3	1.3	1.1	1.2	1.2	1.2	1.0	1.4	1.0	2.9	2.8	0.9	1.0	1.1	1.1	0.7	1.0	0.8
BB4	0.9	1.1	1.1	1.0	1.2	1.0	1.2	0.9	2.4	2.1	0.8	1.2	0.8	0.8	0.8	0.9	0.8

(a) BBCA = Braun-Blanquet Coverage Abundance. BBCA scores are as follows: <1 represents total coverage of less than 5%; >1 to 2 represents total coverage of 5-25%; >2 to 3 represents total coverage of 25-50%.

(b) BB1 through BB3 are test study areas. BB4 is the reference study area. Each study area contains two transects ("a" and "b").

Sources: FPL 2012a, FPL 2012c, FPL 2013d, FPL 2014f, FPL 2015d, FPL 2016m, FPL 2017g, FPL 2018t, FPL 2019h

Figure 3-36a Seagrass Mean Braun-Blanquet Coverage Abundance by Transect, 2010-2018



		2011		2012		2013		2014		2015		2016		2017		2018	
BB1	1.5	2.5	2.4	2.4	2.2	2.3	2.2	2.6	1.7	1.6	2.5	2.7	2.1	1.9	1.8	2.7	2.5
BB2	2.2	2.3	2.4	2.0	1.7	2.4	2.9	1.8	2.5	2.4	3.1	2.6	2.2	2.2	1.4	1.6	1.6
BB3	2.0	2.8	2.1	2.6	2.0	2.6	2.7	1.6	3.1	2.9	2.6	2.5	2.1	1.7	1.4	2.0	2.3
BB4	1.9	2.2	1.8	1.9	2.0	1.9	2.6	2.7	2.4	2.1	2.6	2.3	2.1	2.3	1.3	2.4	2.3

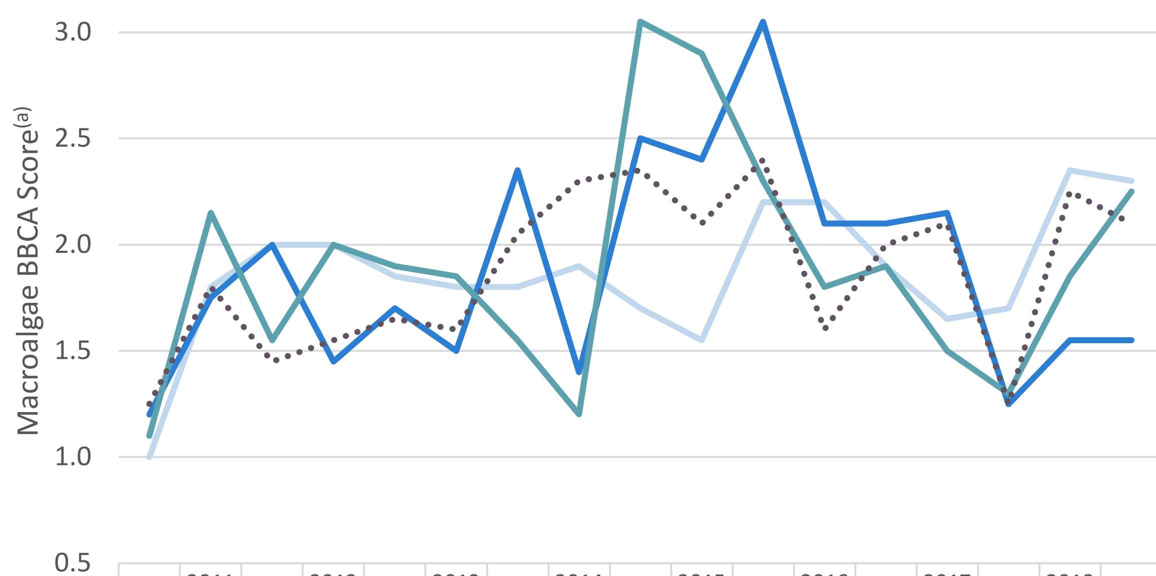
(a) BBCA = Braun-Blanquet Coverage Abundance. BBCA scores are as follows: <1 represents total coverage of less than 5%; >1 to 2 represents total coverage of 5-25%; >2 to 3 represents total coverage of 25-50%.

(b) BB1 through BB3 are test study areas. BB4 is the reference study area. Each study area contains two transects ("a" and "b").

Sources: FPL 2012a, FPL 2012c, FPL 2013d, FPL 2014f, FPL 2015d, FPL 2016m, FPL 2017g, FPL 2018t, FPL 2019h

Figure 3-36b Macrophyte Mean Braun-Blanquet Coverage Abundance by Transect, 2010-2018

In its most recent annual monitoring report, FPL (2018o) reported mean total macrophyte scores ranging from 1.3 (BB2 and BB4 in fall 2017) to 2.7 (BB1 in spring 2018). Macrophytes include seagrass and attached macroalgae after drift red algae has been removed. Mean total seagrass scores ranged from 0.4 (BB2 in fall 2017) to 1.5 (BB1 in spring 2017). Most mean seagrass scores were within the range of values reported in previous monitoring reports with two exceptions. At BB1, the fall 2017 mean was lower than the previous minimum, and the spring 2018 mean was higher than the previous maximum. At BB3, the fall 2017 mean was also lower than the previous minimum. Mean total attached macroalgae (i.e., all species exclusive of drift algae) scores ranged from 1.3 (BB2, BB3, and BB4 in fall 2017) to 2.4 (BB1 in spring 2018), which all fell within the range of values reported in previous monitoring reports. Figure 3-36a, Figure 3-36b, and Figure 3-36c depict seagrass, macrophyte, and macroalgae cover (respectively) by transect from fall 2010 through fall 2018.



		2011		2012		2013		2014		2015		2016		2017		2018	
BB1	1.0	1.8	2.0	2.0	1.9	1.8	1.8	1.9	1.7	1.6	2.2	2.2	1.9	1.7	1.7	2.4	2.3
BB2	1.2	1.8	2.0	1.5	1.7	1.5	2.4	1.4	2.5	2.4	3.1	2.1	2.1	2.2	1.3	1.6	1.6
BB3	1.1	2.2	1.6	2.0	1.9	1.9	1.6	1.2	3.1	2.9	2.3	1.8	1.9	1.5	1.3	1.9	2.3
BB4	1.3	1.8	1.5	1.6	1.7	1.6	2.1	2.3	2.4	2.1	2.4	1.6	2.0	2.1	1.3	2.3	2.1

(a) BBCA = Braun-Blanquet Coverage Abundance. BBCA scores are as follows: <1 represents total coverage of less than 5%; >1 to 2 represents total coverage of 5-25%; >2 to 3 represents total coverage of 25-50%.

(b) BB1 through BB3 are test study areas. BB4 is the reference study area. Each study area contains two transects ("a" and "b").

Sources: FPL 2012a, FPL 2012c, FPL 2013d, FPL 2014f, FPL 2015d, FPL 2016m, FPL 2017g, FPL 2018t, FPL 2019h

Figure 3-36c Macroalgae Mean Braun-Blanquet Coverage Abundance by Transect, 2010-2018

<u>Seagrass Leaf Nutrient Analyses</u>

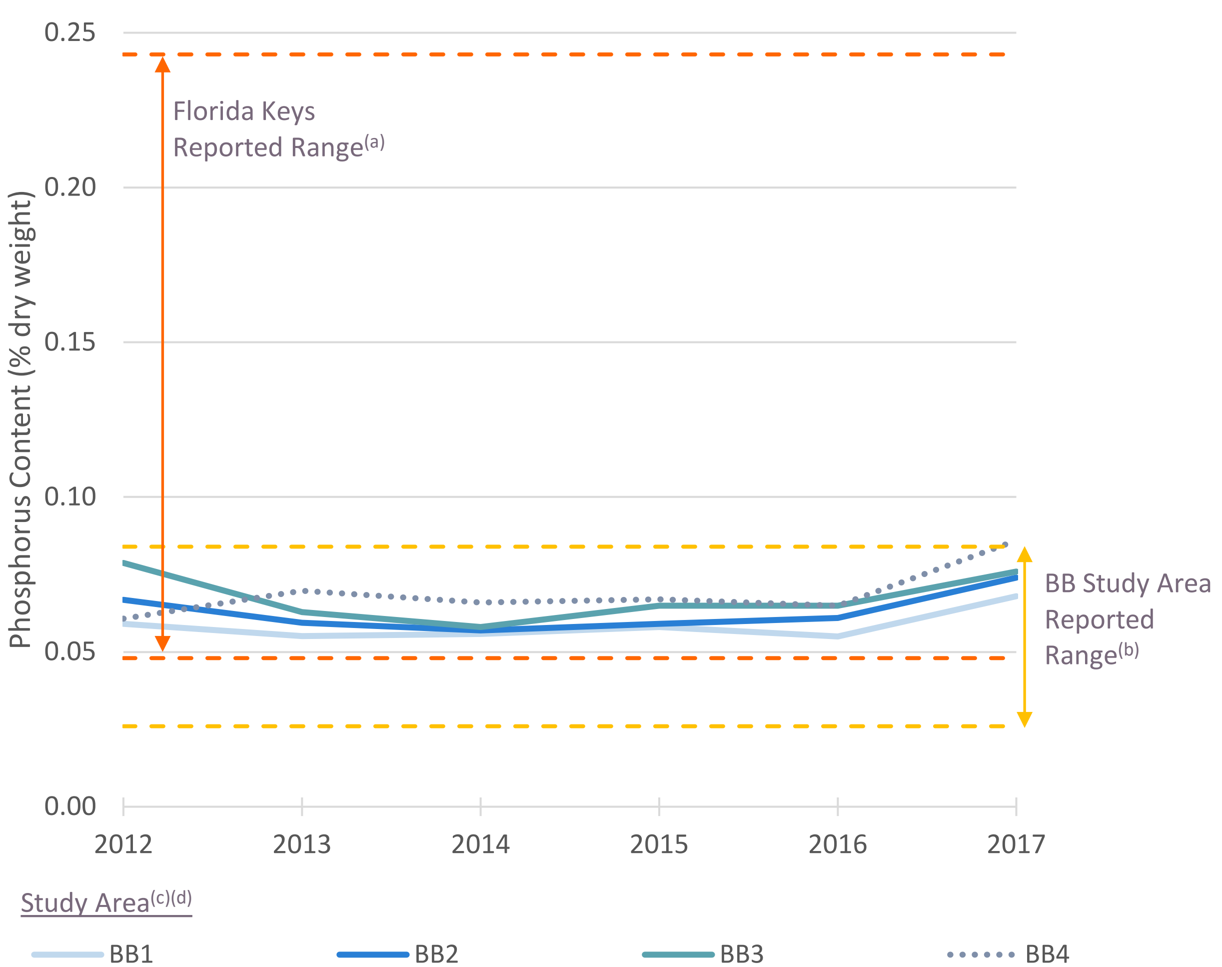
Seagrass growth is controlled in part by the availability of nitrogen and phosphorus within the ecosystem. Seagrasses take up these nutrients through sediment porewater and use them for growth. Studies demonstrate that humans have altered nutrient availability in both groundwater and nearshore marine waters in the Florida Keys region (Lapointe et al. 1990; Lapointe and Matzie 1996). Altering nutrient levels can alter seagrass bed structure (Powell et al. 1989, 1991; Tomasko and Lapointe 1991; Fourqurean et al. 1995). For instance, at sampling sites with nutrient additions in the form of seabird defecation, Powell et al. (1989) observed increased areal leaf production, standing crop, and above-ground biomass within a Florida Bay seagrass community composed of turtle grass and shoal grass. Enriched turtle grass exhibited longer, wider blades, while enriched shoal grass exhibited longer blades and increased short shoot density.

Within Southern Florida and the Florida Keys, phosphorus is generally recognized as the limiting nutrient for primary production in nearshore seagrass communities (Ferdie and Fourqurean 2004; Fourqurean and Zieman 2001; Powell et al. 1989). This occurs because of the strong sorption affinity of phosphorus to limestone, corals, and other calcium carbonate mineral surfaces in this ecosystem, which reduces the amount of bioavailable phosphorus for plant uptake. However, seagrass communities can become nitrogen-limited if natural sources of phosphorus, such as from atmospheric deposition and decaying organic matter, paired with anthropogenic sources of phosphorus, such as from runoff and point source effluent discharges, supply more phosphorus than can be sequestered into sediments and porewater (Erftemeijer and Middelburg 1993; Erftemeijer 1994; Jensen et al. 1998). Nutrient concentrations in seagrass leaf tissue can indicate whether a system is nitrogen- or phosphorus-limited, which can provide valuable information in determining an ecosystem's nutrient loading and relative water quality.

During FPL's (2018o) fall 2017 sampling, turtle grass phosphorus content by study area ranged from 0.068 percent (BB1) to 0.086 percent (BB4) composition by dry weight. By transect, content ranged from 0.066 percent (BB1-a and BB2-a) to 0.090 percent (BB4-a). When compared within the same study areas, seagrass samples from two of the test areas (BB1 and BB2) exhibited phosphorus content values that were slightly higher than FPL's past reported maximum values. Phosphorus values in the third test area (BB3) remained below past reported maximum values within that study area. Phosphorus values in the reference study area (BB4) also exhibited values in 2017 that exceeded past reported values. The reference study area has historically exhibited the highest phosphorus content. None of the test study areas exceeded the reference study area's past reported values in 2017 samples. Additionally, all of FPL's reported phosphorus values to date are within the range of values reported in scientific literature for turtle grass in similar areas of Southern Florida. For instance, Fourqurean and Zieman (2001) sampled turtle grass at 504 randomly chosen locations within the Florida Keys over a 9-year period (1992-2000). In laboratory dry weight analyses, the authors determined that leaf phosphorus content ranged from 0.048 percent to 0.243 percent (mean = 0.113 percent). Figure 3-36d depicts seagrass leaf phosphorus content among all study areas from 2012 through 2017 and shows past value ranges for the Biscayne Bay study areas and the Florida Keys. Figure 3-36e, Figure 3-37f, Figure 3-37g, and Figure 3-37h depict seagrass leaf phosphorus content for individual study areas over the same period.

FPL (2018o) did not report leaf nutrient content values for nitrogen and carbon from 2017. In 2016, FPL (2017g) reported nitrogen content to range from 1.83 percent (BB1) to 1.93 percent (BB4) composition by dry weight. These values are within the range reported by Fourqurean and Zieman (2001) for the Florida Keys and lie close to the authors' observed mean. Fourqurean and Zieman (2001) reported leaf nitrogen content ranging from 0.88 percent to 3.96 percent (mean = 1.82 percent). FPL (2018o) reported total carbon in 2016 to range from 26.33 (BB1) to 27.95 (BB4). Fourqurean and Zieman (2001) reported turtle grass leaf carbon content to range from 29.4 percent to 43.3 percent (mean = 36.9 percent) in the Florida Keys.

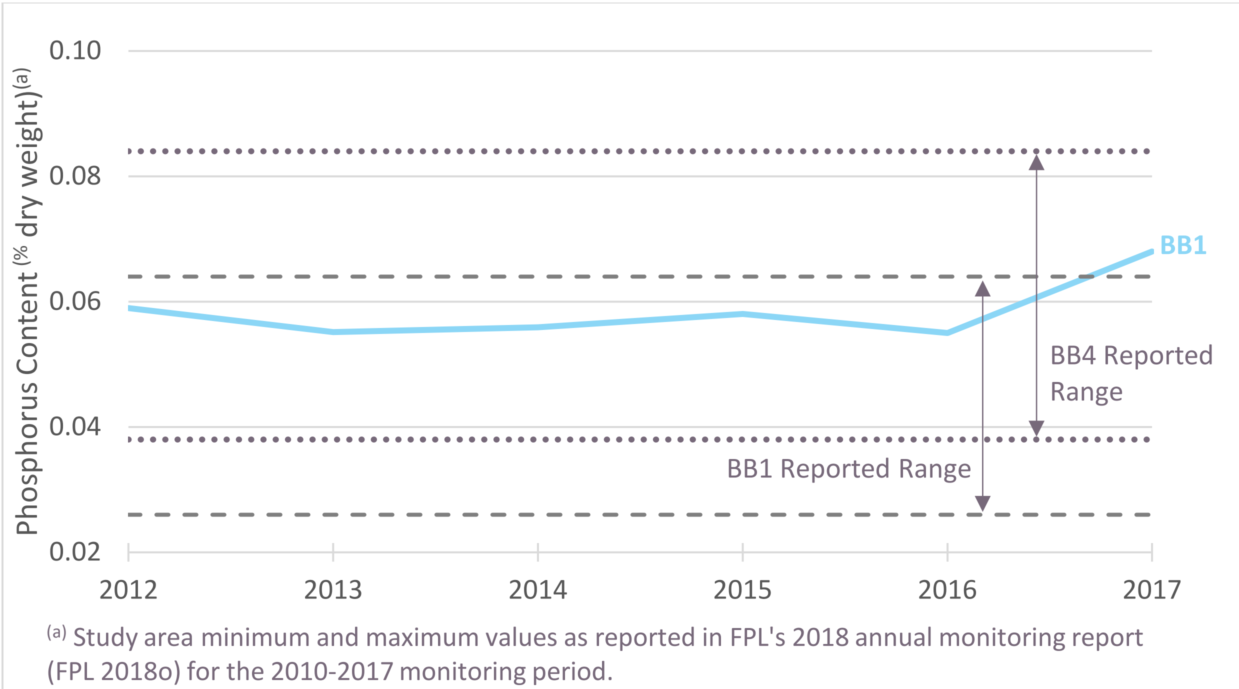
In summary, the above information supports Ecology and Environment Inc.'s major findings, which are encapsulated in two bullets at the beginning of this section. Through the 2018 reporting period, FPL's submerged aquatic vegetation monitoring and seagrass leaf nutrient analyses have consistently demonstrated that marshes and mangroves near the Turkey Point site are characteristic of south Florida's hydrologically modified, nutrient-limited coastal fringe communities. None of the data that the NRC staff reviewed indicate observable ecological impacts from the CCS on the surrounding areas. The NRC staff also identified no clear evidence in the data of CCS water in the surrounding marsh or mangrove areas from a groundwater pathway. Rather, observed ecological changes in marsh and mangrove monitoring plots appear to be seasonally and meteorologically driven.



(a) Florida Keys minimum and maximum values as reported by Fourqurean and Zieman (2001) from 504 sampling points over 9 years (1992-2000).
(b) BB study area minimum and maximum values as reported in FPL's 2018 annual monitoring report (FPL 2018o). Values represent minimum and maximum among all study areas over the 2010-2017 monitoring period. Minimum value (0.026) is from BB1, and maximum value (0.084) is from BB4.
(c) BB1 through BB3 are test study areas. BB4 is the reference study area. Each study area contains two transects ("a" and "b").
(d) Phosphorus content for seagrass leaf samples collected in 2010 and 2011 are not reported in FPL's annual monitoring reports. Data for 2018 will be reported in FPL's 2019 annual monitoring report.

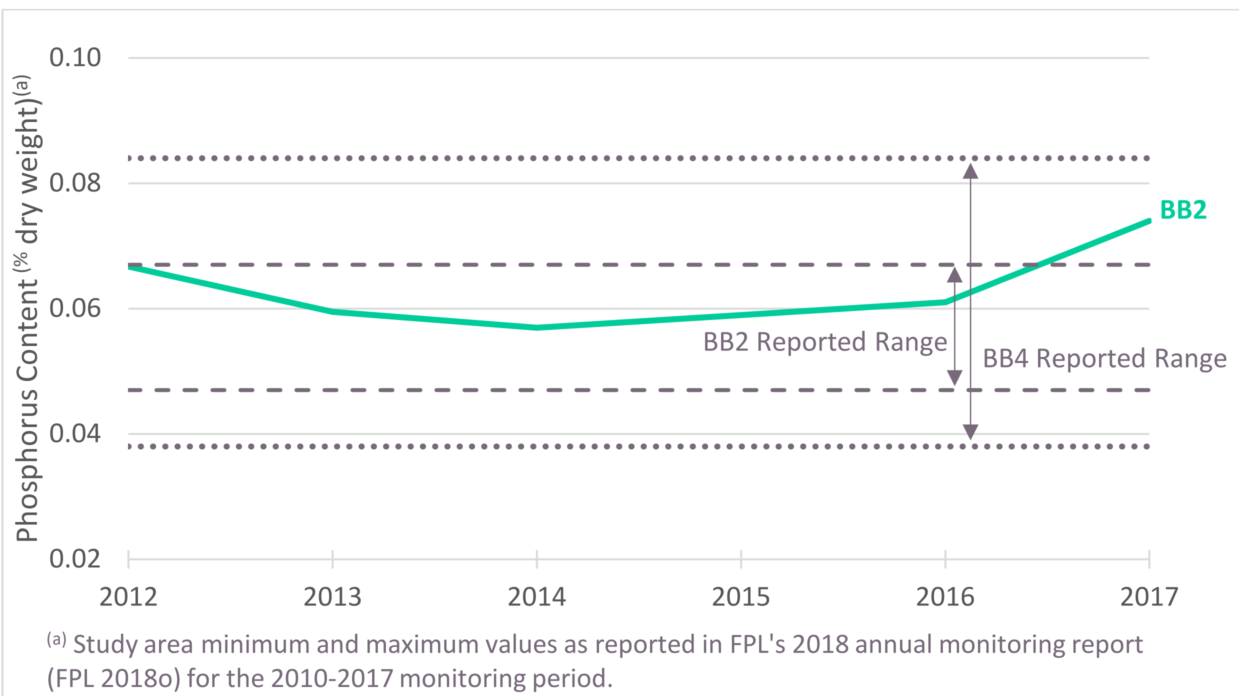
Sources: FPL 2012a, FPL 2012c, FPL 2014b, FPL 2016a, FPL 2016b, FPL 2018o

Figure 3-36d Seagrass Leaf Phosphorus Content by Study Area with Reported Minimum and Maximum Values, 2012-2017



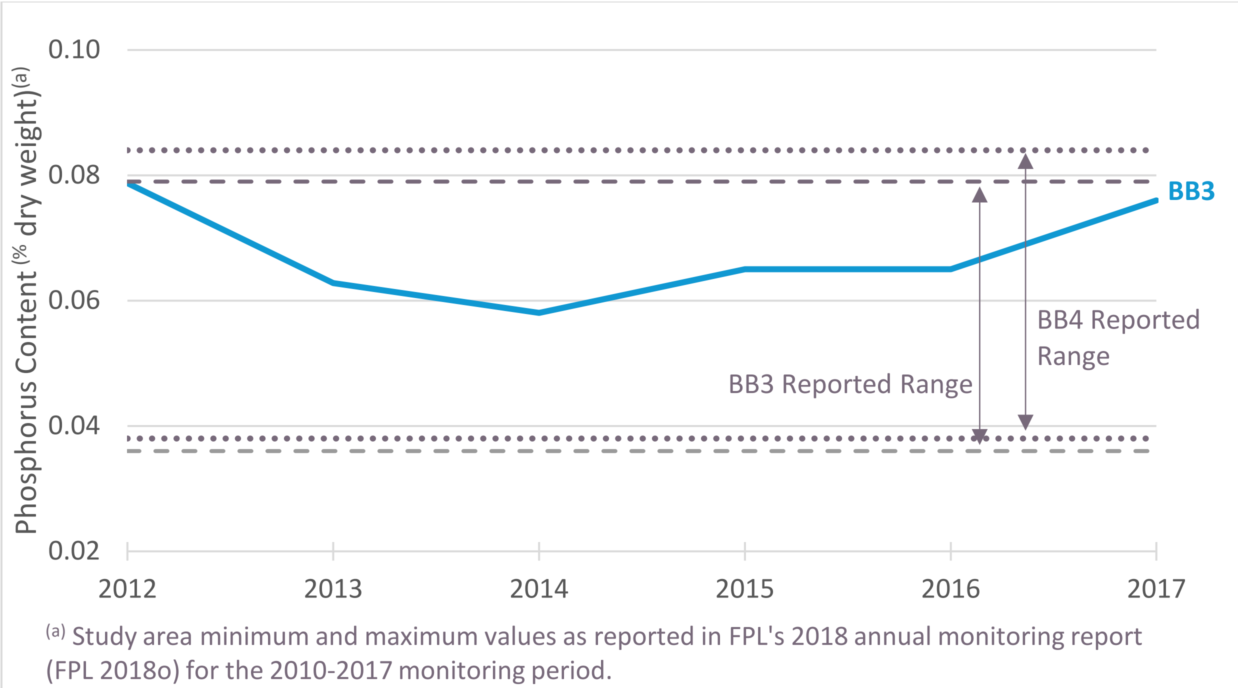
Sources: FPL 2012a, FPL 2012c, FPL 2014b, FPL 2016a, FPL 2016b, FPL 2018o

Figure 3-36e Seagrass Leaf Phosphorus Content at BB-1, 2012-2017



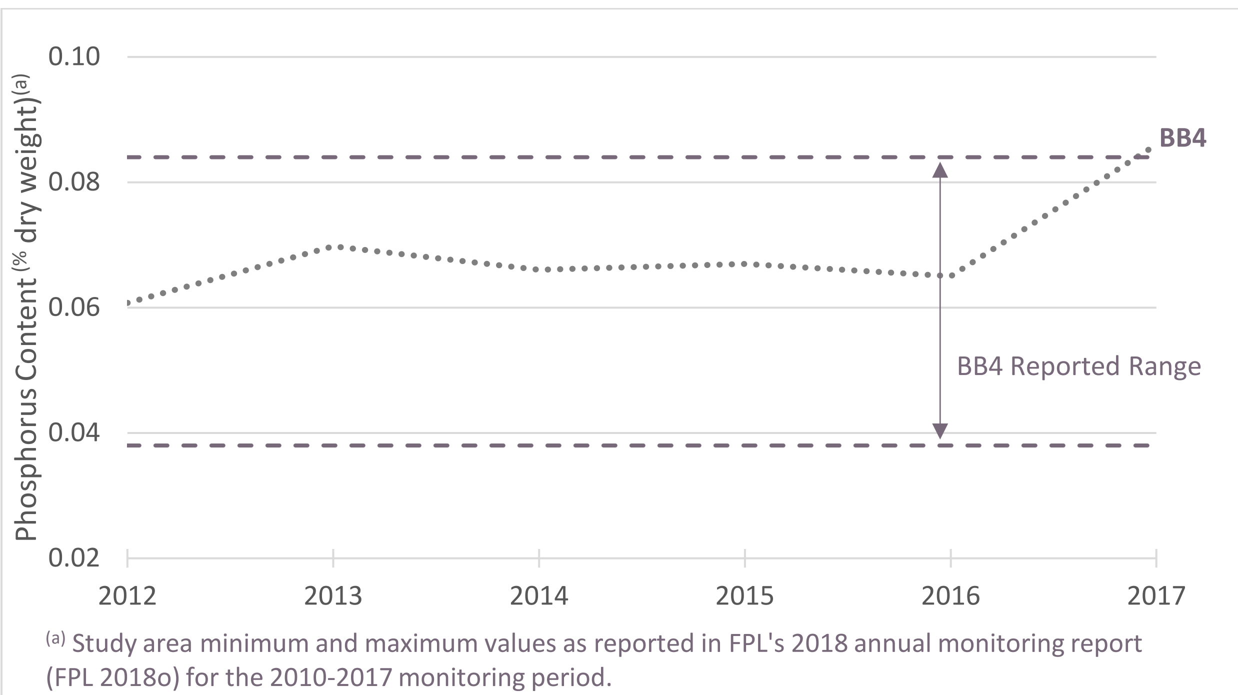
Sources: FPL 2012a, FPL 2012c, FPL 2014b, FPL 2016a, FPL 2016b, FPL 2018o

Figure 3-36f Seagrass Leaf Phosphorus Content at BB-2, 2012-2017



Sources: FPL 2012a, FPL 2012c, FPL 2014b, FPL 2016a, FPL 2016b, FPL 2018o

Figure 3-36g Seagrass Leaf Phosphorus Content at BB-3, 2012-2017



Sources: FPL 2012a, FPL 2012c, FPL 2014b, FPL 2016a, FPL 2016b, FPL 2018o

Figure 3-36h Seagrass Leaf Phosphorus Content at BB-4, 2012-2017

3.7.5 Additional Information on Aquatic Resources

Section 2.4.2, "Aquatic Ecology," of the NRC staff's EIS for Turkey Point Units 6 and 7 combined licenses (NUREG-2176) (NRC 2016a) provides more information on the following aspects of the aquatic environment:

- Turkey Point ecoregion (pages 2-119 to 2-122)
- Historical conditions and anthropogenic alterations to the Turkey Point ecoregion (pages 2-119 to 2-122)
- Detailed descriptions of aquatic resources on the Turkey Point site (pages 2-122 to 2-128; Table 2-18 and Table 2-19)
- Descriptions of the CCS and its water quality through 2016 (pages 2-123 to 2-126)
- Summaries of macroinvertebrate and seagrass surveys performed in near-shore areas of Biscayne Bay in 2008 and 2009 to support the Turkey Point 6 and 7 combined licenses application (pages 2-123 to 2-128 and 2-159 to 2-160; Table 2-18 and Table 2-20)
- Descriptions of nearby aquatic environments, which include Biscayne Bay and its associated park and preserve, Florida Keys National Marine Sanctuary, Card Sound and Canal, the Everglades Mitigation Bank, Everglades National Park, and the Crocodile Lake National Wildlife Refuge (pages 2-128 through 2-134; Tables 2-21 through 2-25)
- Ecologically, commercially, and recreationally important species (pages 2-136 to 2-142; Table 2-27)
- State-listed threatened or endangered species and species of concern (page 2-154 to 2-157; Table 2-30)
- Nonindigenous and invasive species (page 2-142)

The NRC staff incorporates this information from NUREG–2176 as indicated by the section, page, and table numbers above, into this SEIS by reference. The NRC staff did not identify any new or updated information relevant to the description of the aquatic environment beyond the additional information previously described in this section.

3.8 <u>Special Status Species and Habitats</u>

This section addresses species and habitats that are federally protected under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) (ESA), the Magnuson–Stevens Fishery Conservation and Management Act of 1996, as amended (16 U.S.C. 1801 et seq.) (MSA), and the National Marine Sanctuaries Act of 1966, as amended (16 U.S. C. 1431 et seq.) (NMSA). Prior to taking a Federal action, such as the issuance of the proposed Turkey Point subsequent renewed licenses, the NRC has direct responsibilities under these statutes. The sections of this SEIS that describe terrestrial and aquatic resources (Sections 3.6 and 3.7, respectively) address species and habitats protected by other Federal statutes and the State of Florida under which the NRC does not have such responsibilities.

3.8.1 Federally Listed Species and Critical Habitats Protected Under the Endangered Species Act

The FWS and the NMFS jointly administer the ESA. The FWS manages the protection of, and recovery effort for, listed terrestrial and freshwater species, and the NMFS manages the protection of, and recovery effort for, listed marine and anadromous species. The following sections describe the Turkey Point action area and then consider separately those species that could occur in the action area under the jurisdiction of each Service.

3.8.1.1 Turkey Point Action Area

The implementing regulations for Section 7(a)(2) of the ESA define "action area" as all areas affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02, "Definitions"). The action area effectively bounds the analysis of federally listed species and critical habitats because only species and habitats that occur within the action area may be affected by the Federal action.

For the purposes of assessing the potential impacts of Turkey Point subsequent license renewal on federally listed species, the NRC staff considers the action area to consist of the Turkey Point site, including the CCS, as well as Biscayne Bay. While most potential impacts associated with the proposed action would be confined to the Turkey Point site, continued Turkey Point operations would necessitate occasional delivery of large parts and equipment by barge over the course of the subsequent license renewal term. Such deliveries would require barge travel through Biscayne Bay, which is why the NRC staff includes this waterbody in the Turkey Point action area for subsequent license renewal.

The NRC staff recognizes that while the action area is stationary, federally listed species can move in and out of the action area. For instance, a migratory bird species could occur in the Turkey Point action area seasonally as it forages or breeds. Thus, in its analysis, the NRC staff considers not only those species known to occur within the action area, but also those species that may passively or actively move into the action area. The staff then considers whether the life history of each species makes it likely to move into the action area where it could be affected by the proposed Turkey Point subsequent license renewal.

The following sections first discuss endangered or threatened species and critical habitats under the FWS's jurisdiction followed by a discussion of those species under the NMFS's jurisdiction.

3.8.1.2 Federally Listed Species and Critical Habitats under U.S. Fish and Wildlife Service's Jurisdiction

The NRC staff used the FWS's Environmental Conservation Online System (ECOS) Information for Planning and Conservation (IPaC) tool to determine species that may be present in the Turkey Point action area. The ECOS IPaC tool identified 42 federally listed endangered or threatened species under the FWS's sole jurisdiction with the potential to occur in the Turkey Point action area. The IPaC tool also identified designated critical habitat for two of these species in the Turkey Point action area (FWS 2018b) (see Table 3-11). No proposed species, candidate species, or proposed or designated critical habitat occurs within the action area (FWS 2018b). Table 3-11 describes the habitat requirements, occurrence patterns, and Federal status for each of the 42 federally listed species under FWS's sole jurisdiction.

In addition to these 42 species, the FWS (2018b) identified four species for which the FWS and NMFS have joint jurisdiction, including (1) the loggerhead sea turtle (*Caretta caretta*), (2) leatherback sea turtle (*Dermochelys coriacea*), (3) hawksbill sea turtle (*Eretmochelys imbricata*), and (4) the Atlantic Sturgeon (gulf Subspecies) (*Acipenser oxyrinchus (oxyrhynchus) desotoi*). However, the proposed action would have no effect on the nesting habitat of sea turtles or other portions of the life cycle that are under FWS's jurisdiction for these four species (NRC 2018g). The life history and impacts to species under the jurisdiction of NMFS are described in Sections 3.8.1.3, "Federally Listed Species and Critical Habitats under National Marine Fisheries Service's Jurisdiction," and Section 4.8.1.1, "Federally Listed Species and Critical Habitats Protected Under the Endangered Species Act," of this SEIS.

Table 3-11 Federally Listed Species under U.S. Fish and Wildlife Service Jurisdiction

Species	Common Name	Habitat Requirements and Occurrence Patterns	Federally Listed Status[(a)]
		Mammals	
Eumops floridanus	Florida bonneted bat	Suitable roosting (e.g., palm trees, tree cavities, Spanish tiled roofs) and foraging habitat occurs at Turkey Point (FWS 2017a); Observed within the vicinity of Turkey Point (FPL 2018f).	FE
Puma concolor coryi	Florida panther	Florida Panther Focus Area occurs in the vicinity of Turkey Point (FWS 1999); Observed 2 mi west of Turkey Point (SFWMD 2013a).	FE
Puma concolor (all sub species except coryi)	puma	No known occurrences in Florida (FWS 1999; NRC 2016a).	SAT
Trichechus manatus	West Indian manatee	Designated critical habitat occurs adjacent to Turkey Point; Observed in the vicinity of Turkey Point, including canals and nearshore seagrass beds in Biscayne Bay (FPL 2012b).	FT
		Birds	
Ammodramus maritimus mirabilis	Cape Sable seaside sparrow	Suitable habitat (mixed marl prairie) does not occur at Turkey Point; No known occurrences at Turkey Point (NRC 2015a; FPL 2014a).	FE
Ammodramus savannarum	Florida Grasshopper sparrow	Extirpated from Miami-Dade County (FWS 1999).	FE
Aphelocoma coerulescens	Florida scrub-jay	Extirpated from Dade County (FWS 1999).	FT
Caladris rufa	red knot	Suitable habitat, such as mudflats, salt marshes, and mangroves occur onsite (FWS 2017a); Observed onsite (FPL 2014a).	FT
Campephilus principalis	ivory-billed woodpecker	Likely extirpated from the United States; No known occurrences on or near Turkey Point (FWS 1999 NRC 2016a).	FE
Charadrius melodus	piping plover	Suitable wintering habitat occurs onsite and within the vicinity, such as beaches, mudflats, and sandflats (FPL 2014a; FPL 2018f); No documented occurrences onsite (FPL 2014a; NRC 2015a)	FT

Species	Common Name	Habitat Requirements and Occurrence Patterns	Federally Listed Status[a]
Mycteria americana	wood stork	Suitable foraging, resting, and roosting habitat within the CCS and onsite wetlands; Regularly observed onsite (NRC 2015a; EAI 2017; FPL 2018g).	FT
Picoides borealis	red-cockaded woodpecker	No known occurrences within Miami-Dade County (FWS 1999; NRC 2016a).	FE
Rostrhamus sociabilis	Everglades snail kite	Suitable habitat (lowland freshwater marshes) occurs on and near Turkey Point (NRC 2015a); Observed within the Everglades Mitigation Bank adjacent to Turkey Point (FPL 2014a).	FE
Setophaga kirtlandi	Kirtland's warbler	Suitable habitat (dense mangroves) occurs on and near Turkey Point; No known observations onsite (NRC 2016a; FPL 2018f).	FE
Vermivora bachmani	Bachman's warbler	No observations of this species in the United States since 1988 (FWS 1999).	FE
Reptiles			
Alligator mississippiensis	American alligator	Suitable freshwater habitat occurs within the vicinity of Turkey Point (FPL 2018f).	SAT
Crocodylus acutus	American crocodile	Designated critical habitat at Turkey Point; Onsite wetlands provide habitat for nesting, rearing hatchlings, and foraging; Onsite adult and hatchling populations have existed for several decades (FPL 2018f).	FT
Drymarchon corais couperi	eastern indigo snake	Suitable habitat, including freshwater marshes, mangroves, and cleared areas, occurs at Turkey Point; Occasionally observed onsite (FPL 2018g).	FT
Invertebrates			
Anaea troglodyta floridalis	Florida leafwing butterfly	Suitable habitat (pineland croton plants in pine rockland) does not occur at Turkey Point (FWS 2017a; FPL 2018f).	FE
Cyclargus (=Hemiargus) thomasi bethunebakeri	Miami blue butterfly	Only known occurrences are within Key West National Wildlife Refuge (FFWCC undated; FPL 2018f).	FE
Heraclides aristodemus ponceanus	Schaus swallowtail butterfly	Suitable habitat (pineland croton plants in pine rockland) does not occur at Turkey Point (FWS 2017a; FPL 2018f).	FE
Orthalicus reses	Stock Island Tree Snail	Suitable habitat (hardwood hammocks primarily in keys) does not occur at Turkey Point; No known occurrence within the vicinity of Turkey Point (FWS 1999; FPL 2018f).	FT
Strymon acis bartrami	Bartram's hairstreak butterfly	Suitable habitat, which is limited to pine rockland where its host plant pineland croton occurs, does not occur at Turkey Point (FWS 2017a; FPL 2018f).	FE

Species	Common Name	Habitat Requirements and Occurrence Patterns	Federally Listed Status[(a)]
		Flowering Plants	
Amorpha crenulata	crenulate lead-plant	Suitable habitat (pine rockland) does not occur at Turkey Point (FWS 2017a).	FE
Argythamnia blodgettii	Blodgett's silverbush	Limited suitable habitat (coastal berm) may occur onsite; Observed within the vicinity of Turkey Point (FPL 2011b; Gann et al. 2018).	FT
Brickellia mosieri	Florida brickell-bush	Suitable habitat (pine rockland) does not occur at Turkey Point (FWS 2017a).	FE
Chamaesyce deltoidea ssp. *deltoidea*	deltoid spurge	Suitable habitat (pine rockland) does not occur at Turkey Point (FWS 2017a).	FE
Chamaesyce deltoidea pinetorum	pineland sandmat	Suitable habitat (pine rockland) does not occur at Turkey Point (NRC 2015a; 82 FR 6691).	FT
Chamaesyce garberi	Garber's spurge	Suitable habitat (pine rockland) does not occur at Turkey Point (FWS 2017a).	FT
Chromolaena frustrata	Cape Sable thoroughwort	Limited suitable habitat (coastal rock barrens) may occur at Turkey Point. Species does not occur in disturbed areas (FWS 2010a; FPL 2018f; NRC 2016a).	FE
Consolea corallicola	Florida semaphore cactus	Limited suitable habitat (coastal berms) may occur at Turkey Point (78 FR 63796; NRC 2016a); No known occurrences at Turkey Point (NRC 2016a; FPL 2018f).	FE
Cucurbita okeechobeensis ssp. *okeechobeensis*	Okeechobee Gourd	No known occurrences in Miami-Dade County; Not likely to occur at Turkey Point due to lake of suitable habitat (NRC 2016a; Gann et al. 2018; FPL 2018g).	FE
Dalea carthagenensis floridana	Florida prairie-clover	Suitable habitat not likely to occur at Turkey Point because some suitable habitats (i.e. pine rocklands, edges of rockland hammocks, and marl prairies) do not occur at Turkey Point and other suitable habitat (i.e., uplands) have been previously disturbed (NRC 2016a; Gann et al. 2018; FPL 2018g).	FE
Digitaria pauciflora	Florida pineland crabgrass	Suitable habitat (marl prairie and pine rockland) does not occur at Turkey Point (NRC 2016a; Gann et al. 2018; FPL 2018g).	FT
Galactia smallii	Small's milkpea	Suitable habitat (pine rockland) does not occur at Turkey Point (FWS 2017a).	FE
Jacquemontia reclinata	beach jacquemontia	Suitable habitat (pine rockland) does not occur at Turkey Point (FWS 2017a).	FE
Linum arenicola	sand flax	Potential to occur onsite given that this species grows less than 1 mi from Turkey Point and suitable habitat (i.e., pine rocklands, marl prairie, and adjacent disturbed areas) occurs within the vicinity (FPL 2018f).	FE

Species	Common Name	Habitat Requirements and Occurrence Patterns	Federally Listed Status[(a)]
Linum carteri carteri	Carter's small-flowered flax	Suitable habitat (pine rockland) does not occur at Turkey Point (FWS 2017a).	FE
Polygala smallii	tiny polygala	Suitable habitat (pine rockland) does not occur at Turkey Point (FWS 2017a).	FE
Sideroxylon reclinatum ssp. *austrofloridense*	Everglades bully	Suitable habitat (pine rockland habitat, marl prairie habitat, and within the ecotone between both habitats) does not occur at Turkey Point (82 FR 46691).	FT
Warea carteri	Carter's mustard	Extirpated from Miami-Dade County (FWS 1999; FWS 2008a).	FE
		Ferns	
Trichomanes punctatum ssp. *floridanum*	Florida bristle fern	Suitable habitat (rockland hammocks, sinkhole habitats, and tree trunks that are in deep shade) occurs within the vicinity (Gann et al. 2018; NRC 2016a); Potential habitat onsite, although no known occurrences onsite (FPL 2018f).	FE

(a) FE = federally listed as endangered; FT = federally listed as threatened; and SAT = federally listed due to similarity of appearance to another listed species at 50 CFR Part 17, "Endangered and Threatened Wildlife and Plants," under provisions of the Endangered Species Act.

Source: FWS 2018b unless otherwise cited

The FWS (2018b) identifies 23 animals that could occur within the Turkey Point action area. Based on the habitat and occurrence pattern information, which is summarized in Table 3-11, the NRC staff determined that the following six species are extirpated from Miami-Dade County or are not known to occur within Miami-Dade County and, therefore, the NRC will not consider these further within this SEIS:

- Florida grasshopper sparrow (*Ammodramus savannarum*)
- Florida scrub-jay (*Aphelocoma coerulescens*)
- ivory-billed woodpecker (*Campephilus principalis*)
- red-cockaded woodpecker (*Picoides borealis*)
- Bachman's warbler (*Vermivora bachmani*)
- Miami blue butterfly (*Cyclargus* (=*Hemiargus*) *thomasi bethunebakeri*)

The NRC staff also does not consider the following five species further within this SEIS because no suitable habitat for these species occurs on the Turkey Point site, there are no known occurrences of the species on site, and the species would not be expected to occur within the action area given the lack of suitable habitat:

- Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*)
- Florida leafwing butterfly (*Anaea troglodyta floridalis*)
- Schaus swallowtail butterfly (*Heraclides aristodemus ponceanus*)

- Stock Island Tree Snail (*Orthalicus reses*)
- Bartram's hairstreak butterfly (*Strymon acis bartrami*)

The following two species are federally listed because of their similarity in appearance to a federally listed endangered or threatened species. A species that is listed due to similarity of appearance is not biologically endangered or threatened and is not subject to ESA Section 7 consultation. Therefore, this SEIS does not discuss further these two species:

- Puma (*Puma concolor* (all sub species except *coryi*)) which was listed for similarity of appearance to the Florida panther (*Puma concolor coryi*)
- American alligator (*Alligator mississippiensis*) which was listed for similarity in appearance to American crocodile

The FWS (2018b) identifies 19 plant species that could occur within the action area. FPL (2018n, 2018g) is not aware of any federally listed endangered or threatened plant species on the Turkey Point site. The NRC staff did not identify any known occurrence of a federally listed plant species within the action area (FWS 1999, NRC 2016a, FWS 2017a, Gann et al. 2018), although some species have been observed within the vicinity of the action area and have the potential to occur onsite (FPL 2011b). The NRC staff also notes that not all areas of the Turkey Point site have been surveyed for federally listed plants. Based on this limited information, the NRC staff reviewed the habitat requirements for each of the 19 federally listed species in Table 3-11 to determine which plants have potential suitable habitat within the action area. The NRC staff determined that the following 14 federally listed plant species would not be expected to occur within the Turkey Point action area due to the lack of suitable habitat or because the species has been extirpated from Miami-Dade County.

- crenulate lead-plant (*Amorpha crenulata*)
- Florida brickell-bush (*Brickellia mosieri*)
- deltoid spurge (*Chamaesyce deltoidea* ssp. *deltoidea*)
- pineland sandmat (*Chamaesyce deltoidea pinetorum*)
- Garber's spurge (*Chamaesyce garberi*)
- Okeechobee gourd (*Cucurbita okeechobeensis* ssp. *okeechobeensis*)
- Florida prairie-clover (*Dalea carthagenensis floridana*)
- Florida pineland crabgrass (*Digitaria pauciflora*)
- Small's milkpea (*Galactia smallii*)
- beach jacquemontia (*Jacquemontia reclinata*)
- Carter's small-flowered flax (*Linum carteri carteri*)
- tiny polygala (*Polygala smallii*)
- Everglades bully (*Sideroxylon reclinatum* ssp. *austrofloridense*)
- Carter's mustard (*Warea carteri*)

The remaining 15 federally listed species in Table 3-11 may occur within the action area. These are:

- Florida bonneted bat (*Eumops floridanus*)
- Florida panther
- West Indian manatee
- red knot (*Caladris rufa*)
- piping plover (*Charadrius melodus*)
- wood stork (*Mycteria americana*)
- Everglades snail kite (*Rostrhamus sociabilis*)
- Kirtland's warbler (*Setophaga kirtlandi*)
- American crocodile
- eastern indigo snake (*Drymarchon corais couperi*)
- Blodgett's silverbush (*Argythamnia blodgettii*)
- Cape Sable thoroughwort (*Chromolaena frustrata*)
- Florida semaphore cactus (*Consolea corallicola*)
- sand flax (*Linum arenicola*)
- Florida bristle fern (*Trichomanes punctatum* ssp. *floridanum*)

The NRC staff evaluated the potential for the proposed action to affect these species in a biological assessment (NRC 2018n) for the Turkey Point Units 3 and 4 subsequent license renewal. The ESA Section 7 consultation history, life histories of these 15 species, and an evaluation of impacts to these species can be found in the biological assessment. The NRC staff incorporates its biological assessment (NRC 2018n) into this SEIS by reference.

3.8.1.3 Federally Listed Species and Critical Habitats under National Marine Fisheries Service's Jurisdiction

No federally listed endangered or threatened species under the NMFS's jurisdiction occur on the Turkey Point site itself. Six federally listed species under the NMFS's jurisdiction may occur in Biscayne Bay adjacent to the Turkey Point site (see Table 3-12).

Table 3-12 Federally Listed Endangered or Threatened Species Under National Marine Fisheries Service Jurisdiction in Biscayne Bay

Species	Common Name	Distinct Population Segment(s)[(a)]	Federally Listed Status[(b)]
Fish			
Pristis pectinata	smalltooth sawfish	United States	FE
Sea Turtles			
Caretta caretta	loggerhead	—	FT
Chelonia mydas	green	North Atlantic and South Atlantic	FT
Dermochelys coriacea	leatherback	—	FE
Eretmochelys imbricata	hawksbill	—	FE
Lepidochelys kempii	Kemp's ridley	—	FE

[(a)] Under the Endangered Species Act, a Distinct Population Segment is a vertebrate population or group of populations that is discrete from other populations of the species and significant in relation to the entire species.

[(b)] FE = federally listed as endangered and FT = federally listed as threatened at 50 CFR Part 17, "Endangered and Threatened Wildlife and Plants," under the provisions of the Endangered Species Act.

Source: NMFS 2017a

In 2015, the NRC prepared a biological assessment for the above five species as well as other species to assess the impacts of construction and operation of proposed new reactors Turkey Point Units 6 and 7 (NRC 2015b). Section 5.0, "Baseline Conditions for Aquatic Species," of the staff's biological assessment for Turkey Point Units 6 and 7 contains life histories, habitat requirements, status and distributions, factors contributing to the species' decline, and the occurrence and status in the project area of the smalltooth sawfish and four sea turtles identified in Table 3-12 on the pages identified as follows:

- smalltooth sawfish (pages 5-15 to 5-18; Figure 5-4 and Figure 5-5)
- loggerhead sea turtle (pages 5-7 to 5-10; Figure 5-3; Table 5-3)
- green sea turtle (pages 5-5 to 5-7; Table 5-2)
- leatherback sea turtle (pages 5-12 to 5-13; Table 5-5)
- hawksbill sea turtle (pages 5-10 to 5-12; Table 5-4)
- kemp's ridley sea turtle (page 5-13 to 5-15; Table 5-6)

In that biological assessment, the NRC staff also identified sea turtle stranding information for South Florida and in the vicinity of the Turkey Point site in the assessment (pages 5-1 to 5-5; Figure 5-1 and Figure 5-2; Table 5-1). This information, as identified by page, table, and figure numbers above, continues to accurately describe these species. Accordingly, the NRC staff incorporates that information into this SEIS by reference.

Because there are no surface water connections between the CCS and any natural surface water bodies, none of the species under the NMFS's jurisdiction occur in the CCS or on the Turkey Point site itself. However, all five of the federally listed species may be present in Biscayne Bay and are, therefore, considered to be present in the action area. Documented occurrences of smalltooth sawfish in or near the Turkey Point action area are rare, and, if present, would likely consist of juveniles using the near-shore mangrove communities to avoid predation (NRC 2015b). Leatherback and hawksbill sea turtle stranding data indicate that these species would also rarely occur in Biscayne Bay (NRC 2015b). Loggerhead and green sea turtles are more likely to occur in Biscayne Bay based on stranding data, although occurrences of these species within the Turkey Point action area itself are not particularly common (NRC 2015b).

3.8.2 Essential Fish Habitat Protected under the Magnuson–Stevens Act

The South Atlantic Fishery Management Council and the NMFS have designated Essential Fish Habitat (EFH) pursuant to the MSA for a number of federally managed species within Biscayne Bay. During the NRC staff's environmental review for the Turkey Point Units 6 and 7 combined license application, the NRC staff worked with the NMFS to identify those species with EFH present near the Turkey Point site. Table 3-13 identifies these species, the applicable fisheries management plan, and relevant EFH habitat designations. During the preparation of this SEIS, the NRC staff confirmed through the NMFS's EFH Mapper that these designations remain valid and that no new EFH has been designated in the vicinity of Turkey Point since the staff's environmental review of the Turkey Point Units 6 and 7 combined license application.

Table 3-13 Designated Essential Fish Habitat near the Turkey Point Site

Species	Common Name	Applicable Fishery Management Plan[a]	Essential Fish Habitat Designation[b]	
			Mangrove	Seagrass and Unconsolidated Bottom
Farfantepenaeus duorarum	pink shrimp	Shrimp Fishery	x	x
Haemulon plumieri	white grunt	Snapper-Grouper		x
Lutianus analis	mutton snapper	Snapper-Grouper		x
Lutjanus griseus	gray snapper	Snapper-Grouper	x	x
Panulirus argus	spiny lobster	Spiny Lobster	x	x

[a] The Fishery Management Councils and the NMFS designate EFH for federally managed species through fishery management plans.

[b] Biscayne Bay and Biscayne National Park are also EFH Habitats of Particular Concern for coral, coral reefs, and hard-bottom communities.

Sources: NMFS 201a, NRC 2015c, NRC 2016a, SAFMC and NMFS 2016a

In 2015, the NRC staff prepared an EFH assessment to assess the impacts of construction and operation of proposed Turkey Point Units 6 and 7 (NRC 2015c). Section 4.0, "EFH Species Life-History Information," of the staff's EFH assessment describes life histories, habitat requirements, distributions, and population statuses of the five federally managed species identified in Table 3-13 on the pages identified as follows:

- pink shrimp (pages 4-4 to 4-5)
- white grunt (page 4-3)
- mutton snapper (page 4-3)
- gray snapper (pages 4-1 to 4-2, Figure 4-1)
- spiny lobster (pages 4 3 to 4-4, Figure 4-2)

The NRC staff also described in its EFH assessment the applicable fishery management plans for these species (page 3-2) and habitat areas of particular concern (page 3-3). This information, as identified above, continues to accurately describe these species, and the NRC staff therefore incorporates it into this SEIS by reference. The NRC staff addressed two additional species—bluestriped grunt (*Haemulon sciurus*) and dog snapper (*Lutianus jocu*) —in its 2015 EFH assessment. However, the South Atlantic Fishery Management Council and the NMFS have since removed these species from the snapper-grouper complex (77 FR 15916, 81 FR 32249). Thus, the Snapper-Grouper Fishery Management Plan no longer identifies EFH for these species.

While EFH for the species identified in Table 3-13 is designated in Biscayne Bay, neither EFH nor the species themselves occur in the CCS or on the Turkey Point site because there are no surface water connections between the CCS and any other natural surface water bodies.

3.8.3 Marine Sanctuary Resources Protected Under the National Marine Sanctuaries Act

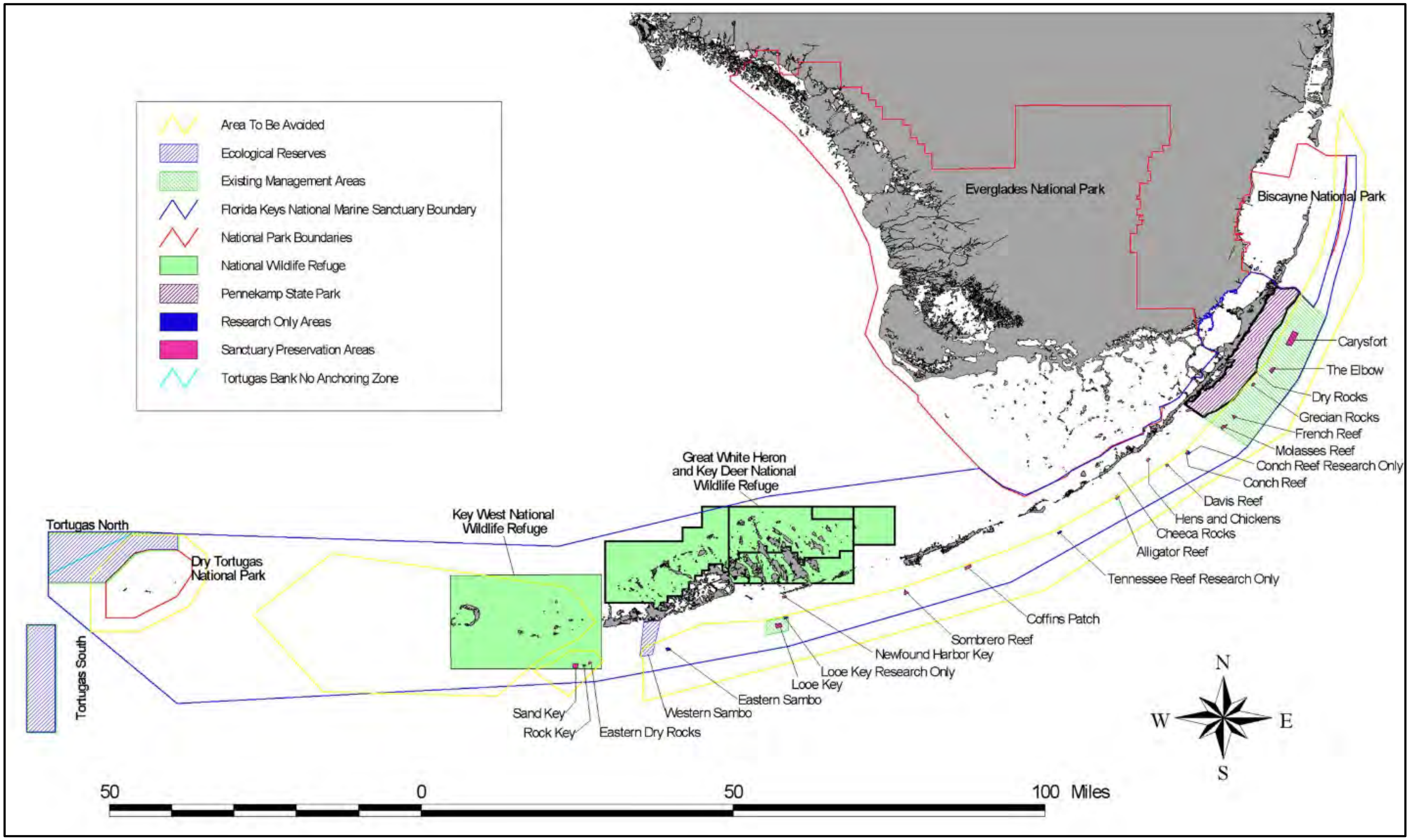
The NMSA authorizes the Secretary of Commerce to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or aesthetic qualities as national marine sanctuaries. The NMSA protects nationally significant aquatic and marine resources and delegates authority to the National Oceanic and Atmospheric Administration to designate and administer marine sanctuaries. The NMSA defines “sanctuary resources” as any living or nonliving resource of a national marine sanctuary that contributes to the conservation, recreational, ecological, historical, educational, cultural, archaeological, scientific, or aesthetic value of the sanctuary (16 U.S.C. 1432(8)).

Within Southern Florida, Congress has designated the Florida Keys National Marine Sanctuary to include 2,900 nautical mi^2 (5,370 nautical km^2) of coastal and ocean waters and submerged land surrounding the Florida Keys from south of Miami westward and encompassing the Dry Tortugas (see Figure 3-37). Congress designated the sanctuary in 1990 and through the consent of the State of Florida, the sanctuary is also effective in State waters. The National Oceanic and Atmosheric Administration and the FDEP jointly manage the sanctuary under a co-trustee agreement.

The Florida Keys ecosystem supports a unique distribution of marine organisms because the Keys serve as a partial barrier between temperate Gulf of Mexico waters and subtropical Western Atlantic Ocean waters. The region supports over 6,000 species of plants, fish, and invertebrates. Unique habitats include the Nation’s only coral reef that lies adjacent to the continent and one of the largest seagrass communities in the hemisphere. The Florida Keys coral reef system includes 520 species of fish, including over 260 species of reef fish; 367 species of algae; 5 species of seagrasses; 117 species of sponges; 89 species of polychaete worms; 128 species of echinoderms; 2 species of fire coral; 55 species of soft corals; and 65 species of stony corals. The area's seagrass beds are among the richest, most productive, and most important submerged coastal habitats because they provide food and habitat for commercially and recreationally important species of fish and invertebrates. Mangroves are another important component of the ecosystem. Mangrove trees and forests fringe the 1,600 islands and 1,800 mi (2,900 km) of shoreline within the Florida Keys National Marine Sanctuary. Mangroves provide habitat for juvenile fish and invertebrates, stabilize sediments, and produce prop-root surfaces for attached organisms such as oysters, sponges, and algae (NOAA 2007).

The primary non-living marine resources within the sanctuary are maritime heritage areas and sites. Shipwrecks in the Keys contain a record of European and American trade routes and historic ship traffic through the Caribbean. Many of these important underwater cultural and historical sites remain undisturbed because of their relative inaccessibility (NOAA 2007).

The marine resources of the sanctuary contribute to both the quality of human life and the economy of the Florida Keys because the environment and economy are inextricably linked in this region. Tourism is the primary industry in the Florida Keys. Visitors participate in snorkeling, scuba diving, boating, recreational fishing, and wildlife viewing. Recreational and commercial fishing are the next most important sectors of the local economy (NOAA 2007).



Source: NOAA 2019

Figure 3-37 Florida Keys National Marine Sanctuary

3.9 Historic and Cultural Resources

This section describes the cultural background and the historic and cultural resources found at Turkey Point and in the surrounding area. Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA) (54 U.S.C. 300101 et seq.), requires Federal agencies to consider the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation an opportunity to review and comment on the undertaking. Undertakings denote a broad range of Federal activities, including the issuance of NRC reactor licenses and permits. Historic properties are defined as resources included on, or eligible for inclusion on, the National Register of Historic Places (National Register). The criteria for eligibility are listed in Title 36, "Parks, Forest, and Public Property," of the *Code of Federal Regulations* (36 CFR) Section 60.4, "Criteria for evaluation," and include (1) association with significant events in history, (2) association with the lives of persons significant in the past, (3) embodiment of distinctive characteristics of type, period, or method of construction, and (4) sites or places that have yielded, or are likely to yield, information important in prehistory or history.

In accordance with 36 CFR 800.8(c), "Use of the NEPA process for section 106 purposes," the NRC complies with the obligation required under Section 106 of the NHPA through its environmental review process under the National Environmental Policy Act of 1969, as amended (NEPA) (42 U.S.C. 4321 et seq). In the context of the NHPA, the area of potential effect (APE) for a license renewal action is the Turkey Point site and its immediate environs. Turkey Point is located within the 9,460 ac (3,828 ha) FPL property. This property constitutes the APE and consists primarily of developed land, open water, and wetlands. These land areas may be impacted by continued maintenance and operations activities during the subsequent license renewal term. The APE may extend beyond the immediate Turkey Point environs if FPL's maintenance and operations activities affect offsite historic properties irrespective of land ownership or control.

In accordance with the provisions of the NHPA, the NRC is required to make a reasonable effort to identify historic properties within the APE. The NRC is required to, in consultation with the SHPO, determine and document the APE and identify historic properties within the APE. If the NRC finds that either there are no historic properties within the APE or the undertaking (subsequent license renewal) would have no effects on historic properties, the NRC provides documentation of this finding to the State historic preservation officer. In addition, the NRC notifies all consulting parties, including Indian tribes, and makes this finding public (through the NEPA process) prior to issuing the renewed license. If historic properties are present and could be affected by the undertaking, the NRC is required to assess and resolve any adverse effects in consultation with the State historic preservation officer and any Indian tribe that attaches religious and cultural significance to identified historic properties. The Florida Division of Historical Resources, within the Florida Department of State, is responsible for preserving and promoting Florida's historical, archaeological, and folk culture resources.

3.9.1 Cultural Background

Humans have occupied the Southern Florida region for about 12,000 years. The NRC staff's EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG–2176), Section 2.7.1 describes in detail the history of human occupation of the Turkey Point site and the surrounding region (NRC 2016a). The NRC staff incorporates this prehistoric occupation description, contained in pages 2-197 through 2-198 of NUREG-2176, into this SEIS by reference. Prehistoric occupation of the area is divided into the following chronological sequence:

- Paleoindian Period (12,000-7,500 BC)
- Archaic Period (7,500-500 BC)
- Formative Period (500 BC -1513 AD)

The history of east coast Florida from European contact to the end of World War II is described on pages 2-199 through 2-201 of NUREG–2176 (NRC 2016a). The NRC staff incorporates these pages into this SEIS by reference. In brief, European arrival and contact with aboriginal people of Southern Florida occurred in 1513 when Spanish explorers arrived on Florida's eastern coast. European colonization resulted in the loss of Tribal lands and the decline of Native American populations. In 1821, Spain ceded Florida Territory to the United States, and Florida was granted statehood in 1845. During World War I, several training facilities were set up in the State of Florida. The State's economy was boosted by the war, primarily through shipbuilding and industrialization of port cities. During World War II, Florida became one of the Nation's major training grounds for various military branches, and the influx of thousands of servicemen and their families increased industrial and agricultural production in Florida. With the establishment of the Everglades National Park in 1947, tourism increased in the area and became one of the major sources of the State's economy. The NRC staff has identified no new and significant information related to the cultural history of the Turkey Point region in its review of FPL's environmental report submitted as part of the subsequent license renewal application (FPL 2018f), during the onsite environmental audit at Turkey Point, or through the scoping process, beyond the information in the EIS for Turkey Point Units 6 and 7.

3.9.2 Historic and Cultural Resources at Turkey Point

Historic and cultural resources in the vicinity of Turkey Point can include prehistoric era and historic era archaeological sites, historic districts, and buildings, as well as any site, structure, or object that may be considered eligible for listing on the National Register of Historic Places (NRHP). Historic and cultural resources also include traditional cultural properties that are important to a living community of people for maintaining their culture. "Historic property" is the legal term for a historic or cultural resource that is included on, or eligible for inclusion on, the NRHP. The staff notes that the vicinity of a site is not equivalent to an APE; rather, it is the area within a 6-mi (9.6 km) radius of the plant, as explained in NUREG–1555, Supplement 1, Rev. 1.

A cultural resource survey was not conducted on the FPL site prior to Turkey Point Units 3 and 4 construction (FPL 2018f). Therefore, it is unknown whether any historic and archeological resources were disturbed during construction of Turkey Point Units 3 and 4. Approximately 28 percent (2,700 ac (1093 ha)) of the site is undeveloped and undisturbed (FPL 2018h). Although no comprehensive cultural resource survey has been completed for the entire Turkey Point site, several cultural resource studies of the site were conducted on portions of the site between 2004 and 2013 (FPL 2018f, Janus 2009, FPL 2018h). FPL estimates that approximately 10 percent of the Turkey Point site (approximately 950 ac (384 ha)) has been surveyed collectively between these cultural resource surveys (FPL 2018h). These cultural resource studies did not identify archeological sites or historic resources on the Turkey Point site areas that were surveyed, and they concluded that the Turkey Point site has a low archeological potential (FPL 2018f and Janus 2009).

During the NRC staff's environmental site audit, the NRC staff became aware of three wooden buildings that were part of a Boy Scouts of America camp and a cottage (known as the Range House/McGregor Smith Cottage) that are over 50 years old and could have potential historic significance (FPL 2018h). The Boy Scout camp was constructed by FPL between 1962 and 1963 (FPL 2018m). After FPL completed construction of the cooling canals in the early 1970s, the Boy Scout camp was no longer used for Boy Scout activities (FPL 2018m). FPL has maintained and repaired the three wooden structures associated with the former Boy Scout camp, and now uses these structures for storage (NRC 1972, FPL 2018h, FPL 2018m). Two of these structures have gable roofs, and the third has a pyramid roof. Although they have not yet been formally evaluated, FPL has indicated that the three structures do not appear to meet the criteria for listing on the NRHP (FPL 2018h, FPL 2018m).

The Ranger House/McGregor Smith Cottage is a wood frame elevated structure supported by large cylindrical wooden posts; the ground floor space and second level wraparound porch are enclosed with screens (MDC 2018d). The structure was built sometime between 1965 and 1968 for the purposes of housing a full-time Florida Board of Conservation ranger (FPL 2018m). The structure is named after McGregor Smith, one of Florida Power & Light's first presidents (from 1939–1954), who later served as chief executive officer. According to FPL, McGregor Smith is also known for his involvement with the Boy Scouts and Southern Florida economic development (FPL 2018h). Past use of the cottage included use as a meeting space during construction of Turkey Point and as a construction office and fish camp during the 1980s. During the 1990s, the cottage was renovated to make it a habitable residence for senior FPL staff (FPL 2018m). In 2012, FPL contacted the Miami-Dade County's Office of Historical Resources to discuss designation of the Ranger House/McGregor Smith Cottage for historical landmark status and potential restoration of the cottage. According to Miami-Dade County's Office of Historical Resources, McGregor Smith was an important figure in the history of the Florida Power & Light Company and the cottage "played a significant role in the early history of the FPL power plant at Turkey Point and is worthy of saving for future staff use and as a vestige of the flurry of activity that once took place in and around the power plant during the 1960s." However, in 2012 when FPL contacted the Miami-Dade County's Office of Historical Resources, the Ranger House/McGregor Smith Cottage had not yet met the 50-year benchmark required for consideration for eligibility for listing in the NRHP (MDC 2018d). As of the date of publication of this SEIS, FPL has not evaluated the Ranger House/McGregor Smith Cottage for eligibility for listing in the NRHP (FPL 2018h).

FPL conducted a desktop study of offsite cultural resources within the vicinity of Turkey Point. Within a 6-mi (9.6 km) radius of the Turkey Point site, there are 95 known historic and cultural resources. Of these, 28 resources are ineligible for listing, 65 resources have not been evaluated for listing, and 2 resources have been determined eligible for listing in the NRHP (FPL 2018f).

3.10 <u>Socioeconomics</u>

This section describes current socioeconomic factors that have the potential to be directly or indirectly affected by changes in operations at Turkey Point. Turkey Point and the communities that support it can be described as a dynamic socioeconomic system. The communities supply the people, goods, and services required to operate the nuclear power plant. Power plant operations, in turn, supply wages and benefits for people and dollar expenditures for goods and services. The measure of a community's ability to support Turkey Point operations depends on the community's ability to respond to changing environmental, social, economic, and demographic conditions.

3.10.1 Power Plant Employment

The socioeconomic region of influence (ROI) is defined by the area where Turkey Point workers and their families reside, spend their income, and use their benefits, thus affecting the economic conditions of the region. Currently, FPL employs a permanent workforce of approximately 680 workers (FPL 2018f). Approximately 85 percent of this workforce resides in Miami-Dade County (Table 3-14). The remaining workers are spread among 12 counties in Florida and Georgia, with numbers ranging from 1 worker to 49 workers per county (FPL 2018f). In addition to permanent Turkey Point plant employees, FPL hires contract workers to support plant operations. In 2017, FPL employed 366 onsite contract workers; 80 percent of the contract workers resided in Miami-Dade County. The number of contract workers employed each year has remained relatively stable for the last 5 years with the exception of one year. In 2013, FPL employed 763 onsite contract workers as a result of the extended power uprate for Turkey Point (FPL 2018h). Since the majority of permanent workers (85 percent) and contract workers (80 percent) reside in Miami-Dade County, the most significant socioeconomic effects of plant operations are likely to occur in this county. The focus of the impact analysis and region of influence, therefore, is on the socioeconomic impacts of continued Turkey Point operations during the subsequent license renewal period on Miami-Dade County.

Table 3-14 Residence of Permanent Turkey Point Employees by County

County	Number of Employees	Percentage of Total
Total	679	100
Florida		
Broward	49	7
Miami-Dade	577	85
Monroe	40	6
Palm Beach	4	1
Other states and counties	9	1

Source: FPL 2018f

Refueling outages for Turkey Point Units 3 and 4 occur on a staggered 18-month schedule for each unit and have historically lasted 25 to 35 days per unit. During refueling outages, onsite employment typically increases by an additional 1,200 workers. As there are no subsequent license renewal-related refurbishment activities, FPL has no plans to add additional employees to support plant operations during the subsequent license renewal period (FPL 2018f).

3.10.2 Regional Economic Characteristics

This section presents information on employment and income in the Turkey Point socioeconomic region of influence.

3.10.2.1 Regional Employment and Income

In 2016, the Miami-Dade County civilian labor force was approximately 1,370,950 individuals (USCB 2016a). From 2011 to 2016, the labor force in Miami-Dade County increased by

5.6 percent (USCB 2016a and USCB 2011). From 2011 to 2016, the number of employed people in Miami-Dade County increased by 14 percent.

According to the U.S. Census Bureau's (USCB's) 2016 American Community Survey 1-year Estimates, educational services, and health care and social assistance represents the largest employment sector in Miami-Dade County (approximately 20 percent), followed by professional, scientific, and management, and administrative and waste management services (approximately 13 percent). A list of employment by industry in Miami-Dade County is provided in Table 3-15. Turkey Point's permanent workforce residing in Miami-Dade County represents approximately 0.04 percent of Miami-Dade County's employed civilian labor force. Estimated income information for the Miami-Dade County and Florida, for comparison, is presented in Table 3-16. National parks in the vicinity of Turkey Point, such as Biscayne National Park and the Everglades National Park, attract visitors that support economic activity. For instance, in 2017, Biscayne National Park and the Everglades National Park supported approximately 1,680 jobs and $65,319,000 in labor income (NPS 2018b).

Table 3-15 Employment by Industry in Miami-Dade County (2016 Estimates)

Industry	Miami-Dade County	Percent
Agriculture, forestry, fishing and hunting, and mining	9,929	0.8
Construction	103,636	8.0
Manufacturing	57,130	4.4
Wholesale trade	46,086	3.6
Retail trade	158,752	12.3
Transportation and warehousing and utilities	106,084	8.2
Information	23,941	1.9
Finance, insurance, real estate, rental, leasing	97,194	7.5
Professional, scientific, and administrative and waste management services	160,672	12.5
Educational services, and health care and social assistance	252,384	19.6
Arts, entertainment, recreation, accommodation and food services	149,588	11.6
Other services (except public administration)	79,895	6.2
Public administration	44,806	3.5
Total Employed Civilian Workers	1,290,097	
Source: USCB 2016a		

Table 3-16 Estimated Income Information for Miami-Dade County and Florida (2016 Estimate)

	Miami-Dade County	Florida
Median household income (dollars)[(a)]	45,935	50,860
Per capita income (dollars)[(a)]	25,700	28,621
Families living below the poverty level (percent)	14.7	10.5
People living below the poverty level (percent)	18.3	14.7

[(a)] In 2016 inflation-adjusted dollars

Source: USCB 2016a

3.10.2.2 Unemployment

According to the USCB's 2016 American Community Survey 1-Year Estimates, the unemployment rate in Miami-Dade County was 5.9 percent (USCB 2016a). Comparatively, the unemployment rate in the State of Florida in 2016 was 6.0 percent (USCB 2016b).

3.10.3 Demographic Characteristics

An estimated 702,557 people live within 20 mi (32 km) of Turkey Point, which equates to an average population density of 559 persons per square mile (FPL 2018f). This translates to a Category 4, "Least sparse" population density using NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (NRC 1996) measure of sparseness (greater than 120 persons per square mile within 20 mi). An estimated 3,472,804 people live within a 50-mi (80-km) radius of Turkey Point, which equates to an average population density of 442 persons per square mile. This translates to a Category 4, "In close proximity" measure of proximity (greater than 190 persons per square mile within 50 mi) using NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (NRC 1996). Both a Category 4 measure of sparseness and proximity results in a "High" population category based on Figure C.1 of the license renewal GEIS sparseness and proximity matrix (NRC 1996). "High" population category corresponds to the least sparse population category and sites that are in close proximity to large cities. Therefore, Turkey Point is located in a "High" population area based on the license renewal GEIS sparseness and proximity matrix. As shown in Figure 3-1, Turkey Point is located on the coast and much of the area within a 50-mi (80-km) radius around the site consists of ocean and is unpopulated. Additionally, Everglades National Park, located west of the site, is unpopulated (EPA 2019). The population living within a 50-mi (80-km) radius of Turkey Point is primarily concentrated north, north-northeast, and north-northwest of Turkey Point. The nearest resident is approximately 1.9 mi (3.0 km) away from the site at the Homestead Bayfront Park complex (FPL 2018k).

Table 3-17 shows population percent growth and projections from 1990 to 2060 in Miami-Dade County. Over the last several decades, Miami-Dade County has experienced increasing population. Based on population projections, the population in Miami-Dade County is expected to continue to increase, but at a lower rate.

Table 3-17 Population and Percent Growth in Miami-Dade County 1990–2060

Year	Miami-Dade County	
	Population	Percent Change Since Prior Entry
1990	1,937,094	–
2000	2,253,362	16.3
2010	2,496,435	10.8
2016	2,712,945	8.7[a]
2020	2,872,760	15.1[a]
2030	3,215,054	11.9
2040	3,477,569	8.2
2050	3,811,933	9.6
2060	4,127,087	8.3

[a] Percent change from 2010

Source: Decennial population data for 1970–2010 (USCB 1996, USCB 2000a, USCB 2010a); Estimated population for 2016 (USCB 2016b); Projected population for 2020–2040 (BEBR 2017); Calculated projected population for 2050–2060.

The 2010 Census demographic profile of the Miami-Dade County population is presented in Table 3-18. According to the 2010 Census (USCB 2010a), minorities (race and ethnicity combined) comprised approximately 85 percent of the total population. The largest minority population was Hispanic or Latino of any race (65 percent of the total population; 77 percent of the total minority population). For comparison, according to the 2010 Census, minorities comprised approximately 42 percent of the total state of Florida population (USCB 2010b).

Table 3-18 Demographic Profile of the Population in Miami-Dade County in 2010

Miami-Dade County	
Total Population	2,496,435
Race (Percent of Total Population)	
White	73.8
Black or African American	18.9
American Indian and Alaska Native	0.2
Asian	1.5
Native Hawaiian and Other Pacific Islander	0
Some other race	3.2
Two or more races	2.4
Hispanic, Latino, or Spanish Ethnicity of Any Race	
Hispanic or Latino	1,623,589
Percent of total population	65.0
Minority Population (Including Hispanic or Latino Ethnicity)	
Total minority population	2,112,884
Percent minority	84.6

Source: USCB 2010a

According to the USCB's 2016 American Community Survey 1-Year Estimates, since 2010, minority populations in the Miami-Dade County were estimated to have increased by approximately 232,000 persons (see Table 3-19). The largest increases occurred in the Hispanic or Latino population (nearly 212,000 person increases since 2010, an increase of approximately 13 percent). According to the Census Bureau, minorities comprised 69 percent of the total Miami-Dade County population in 1990 (USCB 1990). By 2000, the county's minority population had increased to 79 percent of the population (USCB 2000b).

Table 3-19 Demographic Profile of the Population in Miami-Dade County, 2016 Estimates

Miami-Dade County	
Total Population	2,712,945
Race (Percent of Total Population)	
White	74.5
Black or African American	17.6
American Indian and Alaska Native	0.2
Asian	1.6
Native Hawaiian and Other Pacific Islander	0
Some other race	4.6
Two or more races	1.6
Hispanic, Latino, or Spanish Ethnicity of Any Race	
Hispanic or Latino	1,835,412
Percent of total population	67.8
Minority Population (Including Hispanic or Latino Ethnicity)	
Total minority population	2,344,897
Percent minority	86.4

Source: USCB 2016b

3.10.3.1 Transient Population

Miami-Dade County can experience seasonal transient population growth as a result of local tourism, recreational activities, or university attendance. For instance, in 2017, Biscayne National Park had approximately 447,000 visitors and Everglades National Park had approximately 1,019,000 visitors (NPS 2017a). In 2016, approximately 200,800 students were enrolled in college or graduate school in Miami-Dade County (USCB 2016c). A transient population creates a demand for temporary housing and services in the area.

Based on USCB's 2016 American Community Survey 1-Year Estimates (USCB 2016d), approximately 216,677 seasonal housing units are located in the four counties within a 50-mi (80-km) radius of Turkey Point (Miami-Dade, Monroe, Broward, and Collier counties). Of those, 66,528 seasonal housing units are located in Miami-Dade County. Table 3-20 presents information about seasonal housing for the counties all partly within the 50 mi (80 km) of Turkey Point. The Greater Miami Convention and Visitors Bureau estimates that in 2018, Miami-Dade County had 433 hotels/motels and approximately 55,450 rooms (GMCVB 2018).

Table 3-20 2016 Estimated Seasonal Housing in Counties Located Within 50 mi (80 km) of Turkey Point

County	Total Housing Units	Total Vacant Units	Vacant Housing Units: for Seasonal, Recreational, or Occasional Use	Percent Vacant Seasonal Housing Units
Miami-Dade	1,021,650	140,884	66,528	6.5
Monroe	53,129	22,811	14,854	27.5
Broward	822,980	141,506	78,911	9.6
Collier	210,147	70,625	56,384	26.8
Total	2,107,906	375,826	216,677	

Source: USCB 2016b and USCB 2016d

3.10.3.2 Migrant Farm Workers

Migrant farm workers are individuals whose employment requires travel to harvest agricultural crops. These workers may or may not have a permanent residence. Some migrant workers follow the harvesting of crops, particularly fruit, throughout rural areas of the United States. Migrant workers may be members of minority or low-income populations. Because they travel and can spend a significant amount of time in an area without being actual residents, migrant workers may be unavailable for counting by census takers. If uncounted, these minority and low-income workers would be underrepresented in the decennial Census population counts.

Since 2002, the Census of Agriculture reports the numbers of farms hiring migrant workers—defined as a farm worker whose employment required travel that prevented the worker from returning to his/her permanent place of residence the same day (USDA 2012). The Census of Agriculture is conducted every 5 years and results in a comprehensive compilation of agricultural production data for every county and parish in the Nation.

Information about both migrant and temporary farm labor (persons working less than 150 days) can be found in the 2017 Census of Agriculture. Table 3-21 presents information on migrant and temporary farm labor in the four counties within a 50-mi radius of Turkey Point. According to the 2017 Census, 5,042 farm workers were hired to work for less than 150 days and were employed on 945 farms in the 4 counties within 50-mi of Turkey Point. The county with the highest number of temporary farm workers (4,339) on 736 farms was Miami-Dade County. Approximately 151 farms in the 4 counties within 50-mi of Turkey Point reported hiring approximately 2,727 migrant workers (USDA 2019).

Table 3-21 2017 Migrant Farm Workers and Temporary Farm Labor in Counties Located within 50 mi of Turkey Point

County	Number of Farms with Hired Farm Labor	Number of Farms Hiring Workers for Less Than 150 Days	Number of Farm Workers Working for Less Than 150 Days	Number of Farms Reporting Migrant Farm Labor	Number of Migrant Workers
Miami-Dade	1,180	736	4,339	133	2,018
Monroe	8	5	N/A	0	0

County	Number of Farms with Hired Farm Labor	Number of Farms Hiring Workers for Less Than 150 Days	Number of Farm Workers Working for Less Than 150 Days	Number of Farms Reporting Migrant Farm Labor	Number of Migrant Workers
Broward	256	151	501	7	23
Collier	83	53	202	11	686
Total	1,527	945	5,042	151	2,727

USDA 2019; N/A= information was not disclosed

3.10.4 Housing and Community Services

This section presents information regarding housing and local public services, including education and water supply.

3.10.4.1 Housing

Table 3-22 lists the total number of occupied and vacant housing units, the housing vacancy rates, and the median value of housing units in Miami-Dade County. Based on USCB's 2016 American Community Survey 1-year estimates (USCB 2016e), there were approximately 1,022,000 housing units in Miami-Dade County, of which approximately 881,000 were occupied. The median value of owner-occupied housing units is $265,200.

Table 3-22 Housing in Miami-Dade County (2016)

Miami-Dade County	
Total housing units	1,021,650
Occupied housing units	880,766
Total vacant housing units	140,884
Percent total vacant	13.8
Owner occupied units	446,018
Median value (dollars)	$265,200
Owner vacancy rate (percent)	1.9
Renter occupied units	434,748
Median rent (dollars/month)	1,201
Rental vacancy rate (percent)	5.2

Source: USCB 2016e

3.10.4.2 Education

The Miami-Dade County Public School District is comprised of 472 schools and approximately 354,000 students. The Miami-Dade County Public School District is the fourth largest school district in the United States (MDCPS 2018). The 2016–2017 Miami-Dade County Public School District total revenue was $4,232 million, of which approximately 59 percent was from local support (see discussion in Section 3.10.5, "Tax Revenues") (MDCPS 2017a).

3.10.4.3 Public Water Supply

The Miami-Dade Water and Sewer Department is the main public water supplier in Miami-Dade County. Miami-Dade County relies on groundwater withdrawn from the Biscayne aquifer and Floridian aquifer (see Section 3.5.2.1 for detailed discussion of these two major aquifer systems). Water is provided by the Miami-Dade Water and Sewer Department through four regional water treatment plants: Hialeah and John E. Preston Water Treatment Plant, the Hialeah Reverse Osmosis Water Treatment Plant, the Alexander Orr, Jr. Water Treatment Plant, and the South Dade Water Supply System (which is comprised of five smaller water treatment plants) (MDC 2014). The Newton Water Treatment Plant (part of the South Dade Water Supply System) serves Turkey Point. In addition to the Miami-Dade Water and Sewer Department, four water suppliers within Miami-Dade County provide water to parts of unincorporated Miami-Dade County and within their municipal boundaries: the City of North Miami, the City of North Miami Beach, Florida City, and City of Homestead. The capacity of wellfields and the water treatment plant facilities' installed capacity are presented in Table 3-23.

Table 3-23 Major Public Water Suppliers in Miami-Dade County

System Name	Wellfield Supply Capacity (mgd)	Installed Treatment Facility Capacity (mgd)	Population Served
City of North Miami	14.96	9.30	91,000
City of North Miami-Beach	39.97	32.0	164,000
City of Homestead	16.99	16.9	65,000
Florida City	4	4	9,700
Miami-Dade Water and Sewer Department Service Areas (Total)	634.01	497.19	2,223,000
Hialeah-Preston Treatment Plant	295	225	
Hialeah Reverse Osmosis Water Treatment Plant	12	10	
Alexander Orr, Jr. Water Treatment Plant	308	248	
South Dade Water Treatment Plants (5 plants) (Total)	19.01	14.19	
Elevated Tank	4.32	-	
Everglades Labor	5.04	-	
Leisure City	4.18	-	
Naranja	1.15	-	
Newton	4.32	-	

mgd: millions of gallons per day

Source: MDC 2014

In 2013, the Miami-Dade Water and Sewer Department system population served was 2,222,944 and annual average daily demand was 302 mgd. Despite increases in population, water use has decreased between 2004 and 2013 by 16 percent. Decrease in water use has been attributed to Miami-Dade County's water use efficiency legislation and implementation of the County's water conservation plan (MDC 2014). According to the Miami-Dade Water Supply Facilities Work Plan (MDC 2014), when taking into consideration water conservation, by 2033, annual average daily water demand in the Miami-Dade Water and Sewer Department service area is projected to be 352 mgd (MDC 2014).

3.10.5 Tax Revenues

The State of Florida does not have a State-level property tax. Private property owners pay property taxes to the county and a local school district and may also pay taxes to regional taxing districts. In Florida, real estate property and tangible personal property are subject to property tax. Property values are set by the county property appraiser and are collected by the county tax collector. The tax rate (millage) is set by each taxing unit. County and school district governments may levy taxes up to 10 mills ($10.00 per thousand of assessed valuation) each. As discussed below, FPL pays property taxes (real and tangible personal property) for Turkey Point to Miami-Dade County, the Miami-Dade School District, and several regional taxing districts (FPL 2018f).

The Miami-Dade County budget is comprised of appropriations from various revenues. The total Miami-Dade County operating revenues for the years 2012 through 2017 are presented in Table 3-24. Property taxes are a significant source of Miami-Dade County funding. For instance, property tax revenues have ranged from 23 to 33 percent of the total Miami-Dade County revenues between 2012 and 2017. Miami-Dade County property taxes fund four separate taxing jurisdictions: Countywide, Unincorporated Municipality Service Area, the Fire Rescue District, and the Library System. Each of the four taxing jurisdictions is responsible for different types of services (MDC 2016b). For instance, the County-wide jurisdiction provides public health and social services, transportation, regional parks, and county roads, the court systems, and the regional sheriff services and jails. Additionally, Miami-Dade County also has a countywide debt and a Fire Rescue District debt millage. The revenue raised from the debt service millage pays outstanding debt for voter-approved general or special obligation bonds. The amount of property tax received by a taxing jurisdiction is a result of the millage rate applied by each county taxing jurisdiction. For 2017, the overall property tax millage rate was 9.7074 (MDC 2016b).

The Miami-Dade County Public School District is a taxing entity separate from Miami-Dade County. The Florida Education Finance Program is the primary mechanism for funding the operating costs of Florida school districts (FLDOE 2017). The Florida Education Finance Program allocates funds to the Miami-Dade County Public School District based on student enrollment (FHR 2010). Funding for school districts comes from State, local, and Federal sources. Local funding is obtained primarily from property taxes levied by Florida's counties, each of which constitutes a school district. Property taxes on properties located within the school district are levied after the millage rate is certified. Table 3-24 presents the Miami-Dade County School Board revenues for years 2012 through 2017. Property tax revenues provided approximately 45 to 52 percent of the total Miami-Dade County School Board revenues for years 2012 through 2017.

Miami-Dade County also imposes special district millage. These include the Children's Trust Authority, the Everglades Construction Project, the Okeechobee Basin, the SFWMD, and the Florida Inland Navigation District (SFWMD 2011a). Fiscal Year 2016–2017 total special district millage for Miami-Dade County was 0.3627 (MDC 2016c).

Table 3-24 Miami-Dade County Total Operating Revenues, Miami-Dade County School Board Revenues, and Florida Power & Light Turkey Point Property Tax Payments for Turkey Point Units 3 and 4 (2012–2017)

	2012	2013	2014	2015	2016	2017
Miami-Dade County Total Operating Revenues (in billions of dollars)	5.399	5.375	5.423	5.612	5.792	4.865
Miami-Dade County School Board Revenues (in billions of dollars)	3.222	3.302	3.524	3.581	3.631	3.729
Turkey Point Units 3 and 4 total property tax paid (in millions of dollars)	6.653	29.613	40.594	38.995	37.882	36.570
Tax payment assigned to Miami-Dade County (percent of total Miami-Dade County Revenues)	3.446 (0.06)	15.280 (0.3)	21.108 (0.3)	20.394 (0.5)	20.229 (0.4)	19.858 (0.4)
Tax payment assigned to Miami-Dade County School District (percent of total Miami-Dade County School Board Revenues)	2.834 (0.08)	12.792 (0.4)	17.374 (0.5)	16.665 (0.5)	15.796 (0.4)	14.957 (0.4)
Tax payment assigned to special districts	0.372	1.629	2.070	1.911	1.856	1.755

Sources: FPL 2018f, FPL 2018h, MDC 2015b, MDC 2016b, MDC 2017f, MDCPS 2017b

FPL pays property taxes (real and tangible personal property) for Turkey Point to Miami-Dade County, the Miami-Dade County Public School District, and several regional taxing districts (FPL 2018f). Turkey Point property tax payment for 2012–2017 are presented in Table 3-24. The increase in property tax payment from 2012 to 2013 and from 2013 to 2014 is a result of plant modifications conducted to support an extended power uprate and the lien date (FPL 2018f and FPL 2018h). On June 15, 2012, the NRC granted a license amendment to FPL for an extended power uprate of Turkey Point (NRC 2012). Plant modifications and upgrades for the extended power uprate occurred in 2012 and 2013 and the valuation of the plant upgrades conducted in one year become taxable in the following year. This resulted in the Turkey Point property tax increases observed in 2013 and 2014. Turkey Point property tax payments to Miami-Dade County and Miami-Dade County Public School District have represented less than 1 percent of the Miami-Dade County revenue and of Miami-Dade County Public School District tax revenues. FPL does not expect there to be a notable or significant change to future property tax payments during the subsequent license renewal period (FPL 2018f).

In addition to property tax payments, FPL pays sales tax to Miami-Dade County for purchases. In 2017, FPL paid approximately $224,000 in sale taxes to Miami-Dade County from Turkey Point operation expenses (FPL 2018h). FPL also contributes $1.5 million annually to community organizations (FPL 2018h).

3.10.6 Local Transportation

The transportation network surrounding the Turkey Point site is comprised of U.S. highways, Interstate highways, local streets, and waterways. There are no ports or rail systems located within 6 mi (9.6 km) of the Turkey Point site. The nearest rail line, provided by CSX Corporation, is located approximately 10 mi (16 km) west of the Turkey Point site in Homestead, FL, and the Port of Miami is located approximately 23 mi (37 km) north of the site (CSX 2018). The NRC staff's EIS for the Turkey Point Units 6 and 7 combined license application (NUREG–2176) describes this transportation network in Section 2.5.2.3 (NRC 2016a); the NRC staff incorporates pages 2-175 through 2-178 of NUREG–2176 into this SEIS by reference.

Access to the Turkey Point site is via East Palm Drive (SW 344 St). East Palm Drive is a four-lane road that turns into a two-lane road at its intersection with Tallahassee Road (SW 137th Avenue) as it leads to the Turkey Point site. East Palm Drive intersects with US-1 approximately 8 mi from the Turkey Point Site. East Palm Drive provides access to the Homestead-Miami Speedway and Homestead Bayfront Park. Table 3-25 lists U.S. highways and roads near Turkey Point and their average annual daily traffic (AADT) volumes. The 2017 average annual daily reported two-way traffic volume for the monitoring site closest to Turkey Point on East Palm Drive was 9,800 vehicles.

Table 3-25 2017 Annual Average Daily Traffic in the Vicinity of Turkey Point

Location	Mile Marker	Average Annual Daily Traffic
Palm Drive (SW 344 St.)		
East of SW 132nd Ave Intersection	2.2	9,800
Intersection of Krome Ave (SW-177)	8.6	23,000
US-1 (South Dixie Highway)		
South of Palm Drive Intersection	0.3	32,500
S Krome Ave		
Intersection of Canal Dr (SW 328)	1.7	16,400

Source: FDOT 2017

3.11 Human Health

Turkey Point is both an industrial facility and a nuclear power plant. Similar to any industrial facility or nuclear power plant, the operation of Turkey Point Units 3 and 4 over the subsequent license renewal period will produce various human health risks for workers and members of the public. This section describes the human health risks resulting from the operation of Turkey Point Units 3 and 4, including from radiological exposure, chemical hazards, microbiological hazards, electromagnetic fields, and other hazards.

3.11.1 Radiological Exposure and Risk

Operation of a nuclear power plant involves the use of nuclear fuel to generate electricity. Through the fission process, the nuclear reactor splits uranium atoms resulting very generally in (1) the production of heat which is then used to produce steam to drive the plant's turbines and generate electricity and (2) the creation of radioactive byproducts. As required by NRC regulations at 10 CFR 20.1101, "Radiation protection programs," FPL designed a radiation protection program to protect onsite personnel (including employees and contractor employees), visitors, and offsite members of the public from radiation and radioactive material at Turkey Point.

The Turkey Point Units 3 and 4 radiation protection program is extensive and includes, but is not limited to, the following:

- Organization and Administration (e.g., a radiation protection manager who is responsible for the program and who ensures trained and qualified workers for the program)
- Implementing Procedures
- ALARA (as-low-as-is-reasonably-achievable) Program to minimize dose to workers and members of the public
- Dosimetry Program (i.e., measure radiation dose of plant workers)
- Radiological Controls (e.g., protective clothing, shielding, filters, respiratory equipment, and individual work permits with specific radiological requirements)
- Radiation Area Entry and Exit Controls (e.g., locked or barricaded doors, interlocks, local and remote alarms, personnel contamination monitoring stations)
- Posting of Radiation Hazards (i.e., signs and notices alerting plant personnel of potential hazards)
- Recordkeeping and Reporting (e.g., documentation of worker dose and radiation survey data)
- Radiation Safety Training (e.g., classroom training and use of mockups to simulate complex work assignments)
- Radioactive Effluent Monitoring Management (i.e., controlling and monitoring radioactive liquid and gaseous effluents released into the environment)
- Radioactive Environmental Monitoring (e.g., sampling and analysis of environmental media, such as direct radiation, air, water, groundwater, broad leaf vegetation, fish, shellfish, and sediment to measure the levels of radioactive material in the environment that may impact human health)
- Radiological Waste Management (i.e., controlling, monitoring, processing, and disposing of radioactive solid waste)

Regarding radiation exposure to Turkey Point Units 3 and 4 personnel, the NRC staff reviewed the data contained in NUREG–0713, Volume 39, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors and other Facilities 2017: Fiftieth Annual Report" (NRC 2019b). The fiftieth annual report was the most recent annual report available at the time of this environmental review. It summarizes the NRC's Radiation Exposure Information and Reporting System database's occupational exposure data through 2017. Nuclear power plants are required by 10 CFR 20.2206, "Reports of individual monitoring," to report their occupational exposure data to the NRC annually. Chapter 4, "Environmental Consequences and Mitigating Actions," in this SEIS includes further discussion of radiological doses associated with the Turkey Point Units 3 and 4 subsequent license renewal.

NUREG–0713 calculates a 3-year average collective dose per reactor for workers at all nuclear power reactors licensed by the NRC. The 3-year average collective dose is one of the metrics that the NRC uses in the reactor oversight program to evaluate the applicant's ALARA program. Collective dose is the sum of the individual doses received by workers at a facility licensed to use radioactive material over a 1-year time period. There are no NRC or EPA standards for collective dose. Based on the data for operating pressurized-water reactors like the ones at

Turkey Point Units 3 and 4, the average annual collective dose per reactor was 37 person-rem. In comparison, Turkey Point Units 3 and 4 had a reported annual collective dose per reactor of 44 person-rem.

In addition, as reported in NUREG–0713, for 2017, no worker at Turkey Point Units 3 and 4 received an annual dose greater than 0.75 rem (0.0075 sievert (Sv)), which is much less than the NRC occupational dose limit of 5.0 rem (0.05 Sv) in 10 CFR 20.1201, “Occupational dose limits for adults.”

Offsite dose to members of the public is discussed in Section 3.1.4, “Radioactive Waste Management Systems,” of this SEIS.

3.11.2 Chemical Hazards

State and Federal environmental agencies regulate the use, storage, and discharge of chemicals, biocides, and sanitary wastes. Such environmental agencies also regulate how facilities like Turkey Point manage minor chemical spills. Chemical and hazardous wastes can potentially impact workers, members of the public, and the environment.

FPL currently controls the use, storage, and discharge of chemicals and sanitary wastes at Turkey Point Units 3 and 4 in accordance with its chemical control procedures, waste-management procedures, and Turkey Point site-specific chemical spill prevention plans. FPL monitors and controls discharges of chemical and sanitary wastes through Turkey Point Unit 3 and 4’s NPDES permit process. These plant procedures, plans, and processes are designed to prevent and minimize the potential for a chemical or hazardous waste release and, in the event of such a release, minimize impact to workers, members of the public, and the environment (FPL 2018f).

3.11.3 Microbiological Hazards

Nuclear power plants that discharge thermal effluents to cooling ponds, lakes, canals, or rivers have the potential to promote the increased growth of thermophilic microorganisms, which could result in adverse health effects for plant workers and the public. Microorganisms of particular concern include several types of bacteria (*Legionella* spp., *Salmonella* spp., *Shigella* spp., and *Pseudomonas aeruginosa*) and the free-living amoeba *Naegleria fowleri*, all of which require freshwater environments. Because Turkey Point withdraws from and discharges to the CCS, which is a saline environment, the above freshwater microorganisms are not a concern at Turkey Point, and this SEIS provides no further discussion of them. Section 3.9.3.1 of the license renewal GEIS (NUREG–1437) (NRC 2013a) provides additional background information on these microorganisms.

3.11.4 Electromagnetic Fields

Based on its evaluation in the license renewal GEIS (NUREG–1437), the NRC has not found electric shock resulting from direct access to energized conductors or from induced charges in metallic structures to be a problem at most operating plants. Generally, the NRC staff also does not expect electric shock from such sources to be a human health hazard during the subsequent license renewal period. However, a site-specific review is required to determine the significance of the electric shock potential along the portions of the transmission lines that are within the scope of this SEIS. Transmission lines that are within the scope of the NRC’s subsequent license renewal environmental review are limited to: (1) those transmission lines that connect the nuclear plant to the substation where electricity is fed into the regional distribution system and (2) those transmission lines that supply power to the nuclear plant from the grid (NRC 2013a).

As discussed in Section 3.1.6.5, “Power Transmission Systems,” of this SEIS, the only transmission lines that are in scope for Turkey Point subsequent license renewal are onsite. Specifically, these onsite, in-scope transmission lines are approximately 590 feet (180 m) and connect Units 3 and 4 to the onsite 230-kV switchyard (FPL 2018f). Therefore, there is no potential shock hazard to offsite members of the public from these onsite transmission lines. As discussed in Section 3.11.5, “Other Hazards,” of this SEIS, Turkey Point maintains an occupational safety program, which includes protection from acute electrical shock, and is in accordance with Occupational Safety and Health Administration regulations.

3.11.5 Other Hazards

This section addresses two additional human health hazards: (1) physical occupational hazards and (2) occupational electric shock hazards.

Nuclear power plants are industrial facilities that have many of the typical occupational hazards found at any other electric power generation utility. Nuclear power plant workers may perform electrical work, electric power line maintenance, repair work, and maintenance activities and may be exposed to some potentially hazardous physical conditions (e.g., falls, excessive heat, cold, noise, electric shock, and pressure).

The Occupational Safety and Health Administration (OSHA) is responsible for developing and enforcing workplace safety regulations. Congress created OSHA by enacting the Occupational Safety and Health Act of 1970, as amended (29 U.S.C. 651 et seq.) to safeguard the health of workers. With specific regard to nuclear power plants, plant conditions that result in an occupational risk, but do not affect the safety of licensed radioactive materials, are under the statutory authority of OSHA rather than the NRC as set forth in a memorandum of understanding (NRC 2013f) between the NRC and OSHA. Occupational hazards are reduced when workers adhere to safety standards and use appropriate protective equipment; however, fatalities and injuries from accidents may still occur. Turkey Point Units 3 and 4 maintain an occupational safety program for its workers in accordance with OSHA regulations (FPL 2018f).

3.12 <u>Environmental Justice</u>

Under Executive Order (EO) 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations” (59 FR 7629), Federal agencies are responsible for identifying and addressing, as appropriate, disproportionately high and adverse human health and environmental impacts on minority and low-income populations. Independent agencies, such as the NRC, are not bound by the terms of EO 12898 but are, as stated in paragraph 6-604 of the executive order, “requested to comply with the provisions of [the] order.” In 2004, the Commission issued the agency’s “Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions” (69 FR 52040), which states, ““The Commission is committed to the general goals set forth in [EO] 12898, and strives to meet those goals as part of its NEPA review process."

The Council on Environmental Quality (CEQ) provides the following information in its publication "Environmental Justice: Guidance Under the National Environmental Policy Act" (CEQ 1997):

> *Disproportionately High and Adverse Human Health Effects.*
>
> Adverse health effects are measured in risks and rates that could result in latent cancer fatalities, as well as other fatal or nonfatal adverse impacts on human health. Adverse health effects may include bodily impairment, infirmity, illness, or death. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant (as employed by NEPA) and appreciably exceeds the risk or exposure rate for the general population or for another appropriate comparison group (CEQ 1997).
>
> *Disproportionately High and Adverse Environmental Effects.*
>
> A disproportionately high environmental impact that is significant (as employed by NEPA) refers to an impact or risk of an impact on the natural or physical environment in a low-income or minority community that appreciably exceeds the environmental impact on the larger community. Such effects may include ecological, cultural, human health, economic, or social impacts. An adverse environmental impact is an impact that is determined to be both harmful and significant (as employed by NEPA). In assessing cultural and aesthetic environmental impacts, impacts that uniquely affect geographically dislocated or dispersed minority or low-income populations or American Indian tribes are considered (CEQ 1997).

This environmental justice analysis assesses the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations that could result from the operation of Turkey Point Units 3 and 4 during the subsequent license renewal period of extended operation. In assessing the impacts, the NRC staff used the following definitions of minority individuals, minority populations, and low-income population (CEQ 1997):

> *Minority Individuals*
>
> Individuals who identify themselves as members of the following population groups: Hispanic or Latino, American Indian or Alaskan Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, or two or more races, meaning individuals who identified themselves on a Census form as being a member of two or more races, for example, White and Asian. In other words, everyone except persons who identified themselves as White, Not Hispanic or Latino are considered minority.
>
> *Minority Populations*
>
> Minority populations are identified when (1) the minority population of an affected area exceeds 50 percent or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

Low-income Population

Low-income populations in an affected area are identified with the annual statistical poverty thresholds from the Census Bureau's Current Population Reports, Series P60, on Income and Poverty.

In determining the location of minority and/or low-income populations, the geographic area used to perform a comparative analysis is a 50-mi (80-km) radius from the facility. The 50-mi (80-km) radius is consistent with the impact analysis conducted for human health impacts. The percentage of minority and/or low-income populations in the 50-mi geographic area is compared to the percentage of minority and/or low-income populations in each census block group to determine which block groups exceeds the percentage, thereby identifying the location of these populations (NRC 2013c).

<u>Minority Population</u>

According to the Census Bureau's 2010 Census data, there are a total 2,152 block groups, and approximately 78 percent of the population residing within a 50-mi (80-km) radius of Turkey Point identified themselves as minority individuals (USCB 2010b). The largest minority populations were Hispanic or Latino of any race (approximately 55 percent) followed by Black or African American (approximately 19 percent).

According to the Council on Environmental Quality guidance, a minority population exists if the percentage of the minority population of an area (e.g., census block group) exceeds 50 percent or is meaningfully greater than the minority population percentage in the general population. In this SEIS, the NRC staff's environmental justice analysis applied the meaningfully greater threshold in identifying higher concentrations of minority populations. The meaningfully greater threshold is any percentage greater than the minority population within the 50-mi radius. Therefore, for the purposes of identifying higher concentrations of minority populations, census block groups within the 50-mi (80-km) radius of Turkey Point were identified as minority population block groups if the percentage of the minority population in the block group exceeded 78 percent, which is the percent of the minority population within the 50-mi (80-km) radius of Turkey Point.

As shown in Figure 3-38, minority population block groups are notable and located throughout the 50-mi (80-km) radius of Turkey Point. Based on this analysis, there are 1,247 minority population block groups (using the "meaningfully greater" threshold of 78 percent minority population) within the 50-mi (80-km) radius of Turkey Point and minority population block groups are clustered around the cities of Miami, Miramar, Miami-Gardens, Hialeah, Homestead, Florida City, and the Everglades census county subdivision. Turkey Point is located in a minority population block group.

As presented in Section 3.10, "Socioeconomics," of this SEIS, in 2010, the minority population in Miami-Dade County was approximately 85 percent and the minority population in the State of Florida was approximately 42 percent. According to the Census Bureau's 2016 American Community Survey 1-Year Estimates, since 2010, minority populations in Miami-Dade County have increased by approximately 232,000 persons. The largest increases occurred in the Hispanic or Latino population (nearly 212,000 person increases since 2010, an increase of approximately 13 percent).

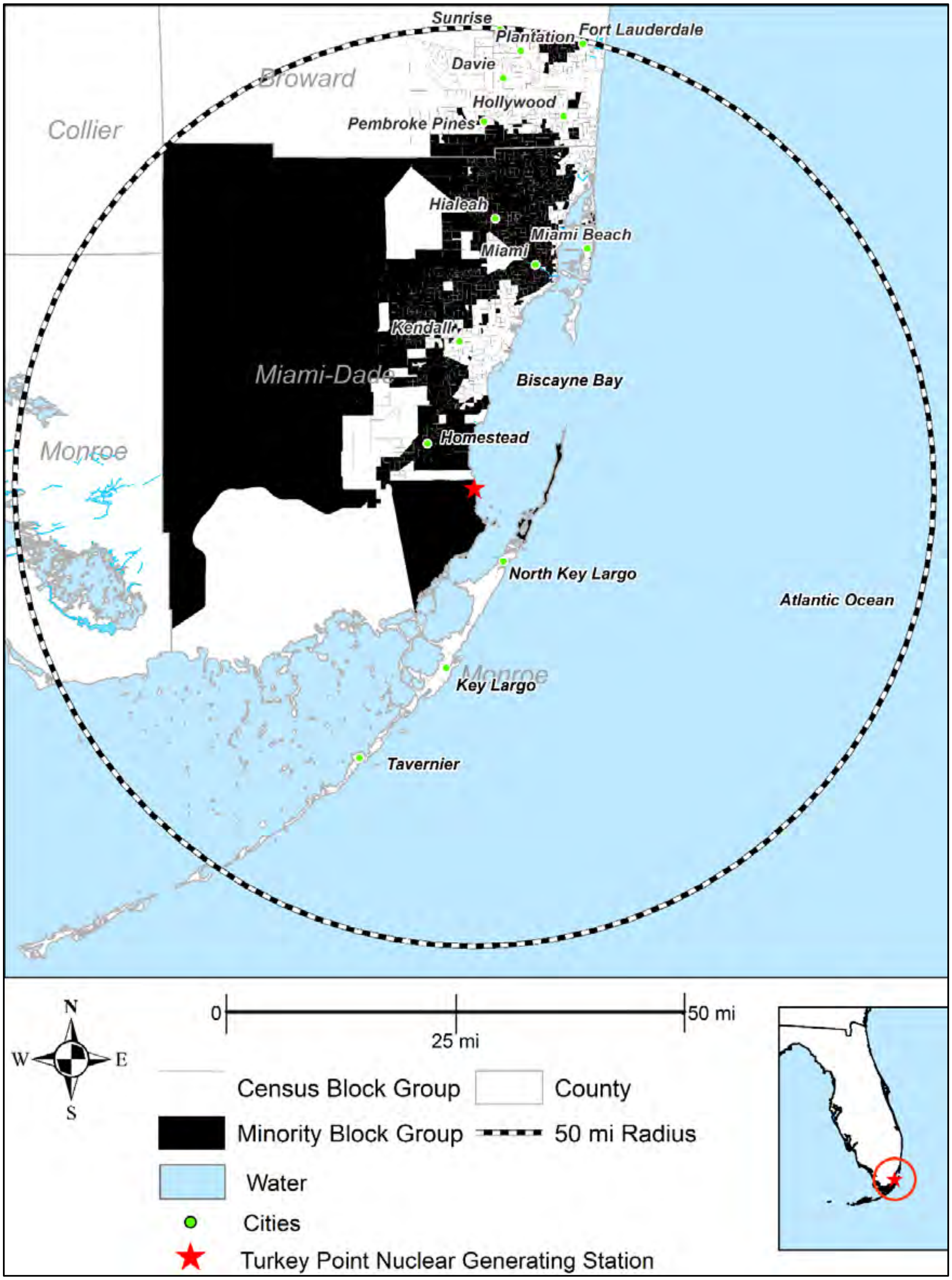
Low-Income Population

The Census Bureau's 2012–2016 American Community Survey data identify approximately 18 percent of individuals residing within a 50-mi (80-km) radius of Turkey Point as living below the Federal poverty threshold (USCB 2016f). The 2016 Federal poverty threshold was $24,563 for a family of four (USCB 2016g).

Figure 3-39 shows the location of predominantly low-income population block groups within a 50-mi (80-km) radius of Turkey Point. In accordance with NRC guidance (NRC 2013a), census block groups were considered low-income population block groups if the percentage of individuals living below the Federal poverty threshold within the block group exceeded 18 percent, which is the percent of the individuals living below the Federal poverty threshold within the 50-mi (80-km) radius of Turkey Point.

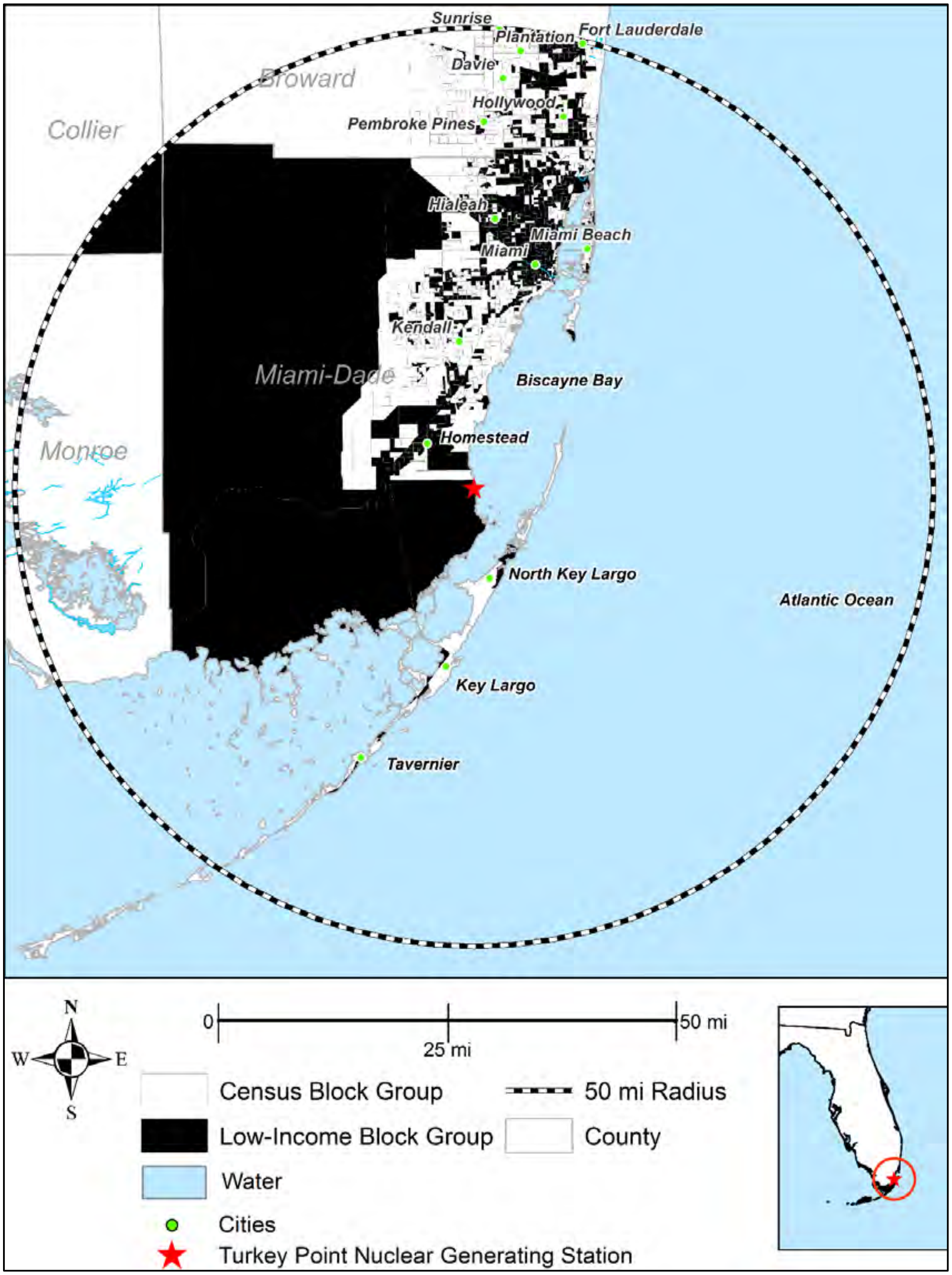
As shown in Figure 3-39, low income population block groups are clustered in the cities of Miami, Hialeah, and Fort Lauderdale, and in the Everglades and Homestead census county subdivisions. Based on this analysis, there are 1,010 low-income population block groups (approximately 50 percent of the block groups within 50 mi (80 km) of Turkey Point) and Turkey Point is located in a low-income population block group.

As presented in Table 3-16, people living in Miami-Dade County (the socioeconomic region of influence) have lower median household and per capita incomes than average for the State of Florida and a higher percentage of families and people living below the poverty level.



Source: USCB 2010b

Figure 3-38 2010 Census—Minority Block Groups Within a 50-mi (80-km) Radius of Turkey Point



Source: USCB 2016f

Figure 3-39 2012–2016, American Community Survey 5-Year Estimates—Low-Income Block Groups Within a 50-mi (80-km) Radius of Turkey Point

3.13 Waste Management and Pollution Prevention

Like any operating nuclear power plant, Turkey Point Units 3 and 4 will produce both radioactive and nonradioactive waste during the subsequent license renewal period. This section describes waste management and pollution prevention at Turkey Point.

3.13.1 Radioactive Waste

As discussed in Section 3.1.4, "Radioactive Waste Management Systems," of this SEIS, Turkey Point uses liquid, gaseous, and solid waste processing systems to collect and treat, as needed, radioactive materials produced as a byproduct of plant operations. Nearly all radioactive materials in liquid and gaseous effluents are reduced prior to being released into the environment so that the resultant dose to members of the public from these effluents is well within NRC and EPA dose standards. Radionuclides that can be efficiently removed from the liquid and gaseous effluents prior to release are converted to a solid waste form for disposal in a licensed disposal facility.

3.13.2 Nonradioactive Waste

Waste minimization and pollution prevention are important elements of operations at all nuclear power plants. Licensees are required to consider pollution prevention measures as dictated by the Pollution Prevention Act (Public Law 101-508) and the Resource Conservation and Recovery Act of 1976, as amended (Public Law 94-580) (NRC 2013a).

As described in Section 3.1.5, "Nonradioactive Waste Management System," Turkey Point has a nonradioactive waste management program to handle nonradioactive waste in accordance with Federal, State, and corporate regulations and procedures. Turkey Point maintains a waste minimization program that uses material control, process control, waste management, recycling, and feedback to reduce waste.

Turkey Point has a Stormwater Pollution Prevention Plan that identifies potential sources of pollution that may affect the quality of stormwater discharges from permitted outfalls. The Stormwater Pollution Prevention Plan also describes best management practices for reducing pollutants in stormwater discharges and assure compliance with the site's FDEP permit.

Turkey Point also has a Spill Prevention, Control, and Countermeasure (SPCC) plan (see FPL's environmental report for subsequent license renewal, Section 9.5.3.6) to monitor areas within the site that have the potential to discharge oil into or upon navigable waters, in accordance with the regulations in 40 CFR Part 112, "Oil Pollution Prevention." The SPCC plan identifies and describes the procedures, materials, equipment, and facilities that FPL uses to minimize the frequency and severity of oil spills at Turkey Point.

Turkey Point is subject to EPA reporting requirements in 40 CFR Part 110, "Discharge of Oil," pursuant to Section 311(b)(4) of the Federal Water Pollution Control Act. Under these regulations, FPL must report to the National Response Center any discharges of oil if the quantity may be harmful to the public health or welfare or to the environment. From 2012 through 2018, FPL reported no oil discharges that triggered the EPA's reporting requirements in 40 CFR Part 110.

Turkey Point is also subject to the reporting provisions of the Florida Administrative Code (FAC) at 62-780.210, Contamination Reporting, concerning the discovery of petroleum or petroleum products contamination or a discharge of petroleum or petroleum products, as well as other FAC reporting requirements. Thus, the NRC staff expects that petroleum and petroleum product spills would be reported to the appropriate regulatory authority.

The NRC staff issued two requests for additional information to FPL regarding reportable spills at Turkey Point. In the first request, the NRC staff asked FPL to provide additional information to the NRC as to whether there have been any reportable spills (discharge of oil) that may be harmful, pursuant to Section 311(b)(4) of the Federal Water Pollution Control Act, that occurred after FPL wrote and submitted its environmental report for the subsequent license renewal application. In its August 2018 response (FPL 2018b, NRC RAI Number: WM-1), FPL stated that "based on the listing of calls received by the U.S. Coast Guard National Response Center, there have been no reportable spills triggering the 40 CFR Part 110 notification requirement at Turkey Point since the ER was written" (USCG 2018).

In its second request for additional information on reportable spills, the NRC staff asked FPL to provide additional information to the NRC as to whether, after the environmental report was written, there have been any reportable spills (discharge of oil) at Turkey Point that may have had the potential to significantly pollute surface waters or groundwater and which were not confined to a building or similar structure. FPL stated in its August 2018 response (FPL 2018g, NRC RAI Number: WM-2) that "There have been no reportable spills triggering the FAC 62-780.110 notification requirement since the ER was submitted."

4 ENVIRONMENTAL CONSEQUENCES AND MITIGATING ACTIONS

4.1 Introduction

In this chapter, the U.S. Nuclear Regulatory Commission (NRC) staff evaluates the environmental consequences of issuing subsequent renewed licenses authorizing an additional 20 years of operation for Turkey Point Nuclear Generating Unit Nos. 3 and 4 (Turkey Point, or Turkey Point Units 3 and 4). The NRC staff's evaluation of environmental consequences includes the following:

1) impacts associated with continued operations similar to those impacts that have occurred during the current renewed license term
2) impacts of various alternatives to the proposed action, including a no-action alternative (not issuing the subsequent renewed licenses); replacement power alternatives (new nuclear; natural gas combined-cycle; and a combination of natural gas and solar power); and an alternate cooling water system alternative using mechanical draft cooling towers.
3) impacts from the termination of nuclear power plant operations and decommissioning after the subsequent license renewal term (with emphasis on the incremental effect caused by an additional 20 years of reactor operation)
4) impacts associated with the uranium fuel cycle
5) impacts of postulated accidents (design-basis accidents and severe accidents)
6) cumulative impacts of the proposed action of issuing subsequent renewed licenses for Turkey Point
7) resource commitments associated with the proposed action, including unavoidable adverse impacts, the relationship between short-term use and long-term productivity, and irreversible and irretrievable commitment of resources
8) new and potentially significant information on environmental issues related to the impacts of operation during the subsequent license renewal term

In this chapter, the NRC staff also compares the environmental impacts of subsequent license renewal with the environmental impacts of the no-action alternative and replacement power alternatives to determine whether the adverse environmental impacts of subsequent license renewal are so great that it would be unreasonable to preserve the option of subsequent license renewal for energy-planning decisionmakers. Chapter 2, "Alternatives Including the Proposed Action," of this supplemental environmental impact statement (SEIS) describes in detail the attributes of the proposed action (subsequent license renewal of Turkey Point) and the no-action alternative. Chapter 2, Section 2.2.2, "Replacement Power Alternatives," further describes the NRC staff's process for developing a range of reasonable alternatives to the proposed action and the replacement power alternatives that the staff selected for detailed analysis in this chapter, including supporting assumptions and data. As noted in Chapter 2, Table 2.1, the site location for various replacement power alternatives would be adjacent to Turkey Point Units 3 and 4. Chapter 2, Table 2.2, summarizes the environmental impacts of the proposed action and alternatives to the proposed action.

The affected environment (i.e., environmental baseline) for each resource area considered, and against which the potential environmental impacts of the alternatives are measured, is described in Chapter 3, "Affected Environment." As documented in Chapter 3, the effects of ongoing reactor operations at Turkey Point have become well established as environmental conditions have adjusted to and reflect the presence of the nuclear power plant.

The environmental impacts of the alternative cooling water system are described in this SEIS within the discussion of each separate resource area (e.g., Sections 4.2.7, 4.3.7, 4.4.7, 4.5.7, 4.6.7, 4.7.7, 4.9.4, 4.10.7, 4.11.7, 4.12.4, and 4.13.7). The benefits of the alternative cooling water system are that the impacts of utilizing the cooling canal system (CCS) for cooling of Turkey Point Units 3 and 4 would be avoided; those impacts are discussed extensively in this SEIS; the avoidance of those impacts of CCS operation (e.g., on groundwater resources) is discussed in Subsection 4.5.2, "No-Action Alternative," in Section 4.5, "Water Resources," in that use of the CCS to cool Units 3 and 4 would cease at the end of the current license terms if the Turkey Point subsequent license renewal (SLR) application is denied.

This SEIS documents the NRC staff's environmental review of the Turkey Point subsequent license renewal application and supplements the information in NUREG–1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (also known as the 2013 GEIS) (NRC 2013a). The 2013 GEIS identifies 78 issues (divided into Category 1 and Category 2 issues) to be evaluated for the proposed action in the environmental review process. Section 1.4, "Generic Environmental Impact Statement," of this SEIS provides an explanation of the criteria for Category 1 issues (i.e., those issues generic to all nuclear power plants or a distinct subset of plants) and Category 2 issues (i.e., those issues specific to individual nuclear power plants) as well as the definitions of SMALL, MODERATE, and LARGE impact significance.

For Category 1 issues, the NRC staff can rely on the analysis in the GEIS unless otherwise noted. Table 4-1 lists the Category 1 (generic) issues that apply to Turkey Point during the proposed subsequent license renewal period. For each Category 1 issue, the NRC staff considered whether there is any new and significant information that might alter the conclusions reached in the GEIS for that issue. As discussed in Section 4.14 of this SEIS, Regulatory Guide (RG) 4.2, Supplement 1, "Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications" (NRC 2013g), defines "new and significant information" as (1) information that identifies a significant environmental impact issue that was not considered or addressed in the GEIS and, consequently, not codified in Table B-1, in Appendix B to Subpart A of 10 CFR Part 51, or (2) information not considered in the assessment of impacts evaluated in the GEIS leading to a seriously different picture of the environmental consequences of the action than previously considered, such as an environmental impact finding different from that codified in Table B-1. For most issues, the NRC staff did not identify any new and significant information during its review of Florida Power & Light Company's (FPL's) environmental report, the site audits, or the scoping period that would change the conclusions in the GEIS. Therefore, there are no impacts related to those Category 1 issues beyond those already discussed in the GEIS. The staff's process for evaluating new and significant information is described in Section 4.14, "Evaluation of New and Significant Information."

The NRC staff identified and evaluated new information for two existing Category 1 issues (i.e., groundwater quality degradation (plants with cooling ponds in salt marshes) and cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds)) and identified one new issue (i.e., water quality impacts on adjacent water bodies (plants with cooling ponds in salt marshes)). The NRC staff's evaluation of these three issues is presented in Sections 4.5.1.1, 4.5.1.2, and 4.6.1 of this SEIS.

Table 4-1 Applicable Category 1 (Generic) Issues for Turkey Point

Issue	GEIS Section	Impact
Land Use		
Onsite land use	4.2.1.1	SMALL
Offsite land use	4.2.1.1	SMALL
Visual Resources		
Aesthetic impacts	4.2.1.2	SMALL
Air Quality		
Air quality impacts (all plants)	4.3.1.1	SMALL
Air quality effects of transmission lines	4.3.1.1	SMALL
Noise		
Noise impacts	4.3.1.2	SMALL
Geologic Environment		
Geology and soils	4.4.1	SMALL
Surface Water Resources		
Surface water use and quality (non-cooling system impacts)	4.5.1.1	SMALL
Discharge of metals in cooling system effluent	4.5.1.1	SMALL
Discharge of biocides, sanitary wastes, and minor chemical spills	4.5.1.1	SMALL
Effects of dredging on surface water quality	4.5.1.1	SMALL
Groundwater Resources		
Groundwater contamination and use (non-cooling system impacts)	4.5.1.2	SMALL
Groundwater quality degradation resulting from water withdrawals	4.5.1.2	SMALL
Groundwater quality degradation (plants with cooling ponds in salt marshes)(a)	4.5.1.2	SMALL(b)
Terrestrial Resources		
Exposure of terrestrial organisms to radionuclides	4.6.1.1	SMALL
Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds)(a)	4.6.1.1	SMALL
Bird collisions with plant structures and transmission lines	4.6.1.1	SMALL
Transmission line right-of-way management impacts on terrestrial resources(c)	4.6.1.1	SMALL
Electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)	4.6.1.1	SMALL
Aquatic Resources		
Entrainment of phytoplankton and zooplankton (all plants)	4.6.1.2	SMALL
Infrequently reported thermal impacts (all plants)	4.6.1.2	SMALL
Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication	4.6.1.2	SMALL

Issue	GEIS Section	Impact
Effects of non-radiological contaminants on aquatic organisms	4.6.1.2	SMALL
Exposure of aquatic organisms to radionuclides	4.6.1.2	SMALL
Effects of dredging on aquatic resources	4.6.1.2	SMALL
Effects on aquatic resources (non-cooling system impacts)	4.6.1.2	SMALL
Impacts of transmission line right-of-way management on aquatic resources[c]	4.6.1.2	SMALL
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	4.6.1.2	SMALL
Socioeconomics		
Employment and income, recreation and tourism	4.8.1.1	SMALL
Tax revenues	4.8.1.2	SMALL
Community services and education	4.8.1.3	SMALL
Population and housing	4.8.1.4	SMALL
Transportation	4.8.1.5	SMALL
Human Health		
Radiation exposures to the public	4.9.1.1.1	SMALL
Radiation exposures to plant workers	4.9.1.1.1	SMALL
Human health impact from chemicals	4.9.1.1.2	SMALL
Microbiological hazards to plant workers	4.9.1.1.3	SMALL
Physical occupational hazards	4.9.4.1.5	SMALL
Postulated accidents		
Design-basis accidents	4.9.1.2	SMALL
Waste Management		
Low-level waste storage and disposal	4.11.1.1	SMALL
Onsite storage of spent nuclear fuel	4.11.1.2	SMALL
Offsite radiological impacts of spent nuclear fuel and high-level waste disposal	4.11.1.3	[d]
Mixed-waste storage and disposal	4.11.1.4	SMALL
Nonradioactive waste storage and disposal	4.11.1.4	SMALL
Uranium Fuel Cycle		
Offsite radiological impacts—individual impacts from other than the disposal of spent fuel and high-level waste	4.12.1.1	SMALL
Offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste	4.12.1.1	[e]
Nonradiological impacts of the uranium fuel cycle	4.12.1.1	SMALL
Transportation	4.12.1.1	SMALL
Termination of Nuclear Power Plant Operations and Decommissioning		
Termination of plant operations and decommissioning	4.12.2.1	SMALL

Issue	GEIS Section	Impact

[(a)] The environmental impact of this issue includes consideration of site-specific new information for Turkey Point.

[(b)] The NRC staff recognizes that the current impacts on this issue are greater than SMALL (i.e., the impacts are MODERATE). However, as discussed in Section 4.5.1.2 of this chapter, in response to a 2015 Consent Agreement with the Miami-Dade County Department of Environmental Resource Management (DERM) (MDC 2015a) and a 2016 Consent Order from the Florida Department of Environmental Protection (FDEP) (FDEP 2016a), FPL has implemented a recovery well system to halt and retract the hypersaline plume and to abate and remediate the effects of the hypersaline plume from the cooling canal system. These efforts are expected to remediate the hypersaline plume prior to the commencement of the subsequent license renewal term. In addition, FPL's actions to remediate the plume are subject to continued regulatory oversight by the DERM and the FDEP. Therefore, the NRC staff expects that groundwater quality degradation impacts resulting from subsequent license renewal will be SMALL.

[(c)] This issue applies only to the in-scope portion of electric power transmission lines, which are defined as transmission lines that connect the nuclear power plant to the substation where electricity is fed into the regional power distribution system and transmission lines that supply power to the nuclear plant from the grid.

[(d)] The environmental impact of this issue for the time frame beyond the licensed life for reactor operations is contained in NUREG–2157, the NRC's "Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel" (NRC 2014c).

[(e)] There are no regulatory limits applicable to collective doses to the general public from fuel-cycle facilities. The practice of estimating health effects on the basis of collective doses may not be meaningful. All fuel-cycle facilities are designed and operated to meet the applicable regulatory limits and standards. The Commission concludes that the collective impacts are acceptable. The Commission concludes that the impacts would not be sufficiently large to require the National Environmental Policy Act (NEPA) conclusion, for any plant, that the option of extended operation under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the collective impacts of the uranium fuel cycle, this issue is considered Category 1.

Source: Table B-1 in Appendix B, Subpart A, to 10 CFR Part 51 and NRC 2013a

The NRC staff analyzed the Category 2 (site-specific) issues applicable to Turkey Point during the proposed subsequent license renewal period and assigned impacts to these issues as shown below in Table 4-2.

Table 4-2 Applicable Category 2 (Site-Specific) Issues for Turkey Point

Issue	GEIS Section	Impact[(a)]
Groundwater Resources		
Groundwater use conflicts (plants that withdraw more than 100 gallons per minute (gpm))	4.5.1.2	SMALL to MODERATE
Radionuclides released to groundwater	4.5.1.2	SMALL
Terrestrial Resources		
Effects on terrestrial resources (non-cooling system impacts)	4.6.1.1	SMALL
Aquatic Resources		
Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)	4.6.1.2	SMALL to MODERATE[(b)]
Thermal impacts on aquatic organisms (plants with once-through cooling systems or cooling ponds)	4.6.1.2	SMALL to MODERATE[(b)]
Special Status Species and Habitats		
Threatened, endangered, and protected species and essential fish habitat	4.6.1.3	Impact determinations vary by species and habitat[(c)]
Historic and Cultural Resources		
Historic and cultural resources	4.7.1	would not adversely affect known historic properties or historic and cultural resources
Human Health		
Chronic effects of electromagnetic fields[(d)]	4.9.1.1.1	Uncertain Impact
Electric shock hazards	4.9.1.1.1	SMALL
Postulated Accidents		
Severe accidents	4.9.1.2	SMALL
Environmental Justice Minority and low-income populations	4.10.1	no disproportionately high and adverse human health and environmental effects
Cumulative Impacts		
Cumulative impacts	4.13	See SEIS Section 4.16

Issue	GEIS Section	Impact[a]

[a] Impact determinations for Category 2 issues are based on findings described in Sections 4.2 through 4.13 of this SEIS for the proposed action.

[b] The conclusion of "SMALL to MODERATE" applies to aquatic resources in the cooling canal system. Aquatic organisms inhabiting Biscayne Bay and connected waterbodies (e.g., Card Sound, the Atlantic Ocean) are not subject to impingement and entrainment because they do not interact with the Turkey Point intake structure, and there are no thermal effects outside the cooling canal system because there are no surface water connections that allow flow between the waters of Biscayne Bay and the cooling canal system.

[c] The NRC staff concludes that Turkey Point subsequent license renewal is likely to adversely affect the American crocodile and the eastern indigo snake, and may result in adverse modification to designated critical habitat of the American crocodile. The NRC staff concludes that proposed action may affect, but is not likely to adversely affect, the Florida panther, West Indian manatee, red knot, wood stork, loggerhead sea turtle, green sea turtle, leatherback sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, and smalltooth sawfish. The NRC staff concludes that the proposed action would result in no adverse modification to designated critical habitat of the West Indian manatee. The NRC staff's evaluation of impacts to federally listed species and critical habitats under the U.S. Fish and Wildlife Service's jurisdiction appears in the NRC's Biological Assessment (NRC 2018n). The FWS's separate evaluation and conclusions appear in a July 25, 2019, biological opinion (FWS 2019b), which is described in Section 4.8.1.1 of this SEIS. The NRC staff's evaluation of impacts to federally listed species and critical habitats under the National Marine Fisheries Service's jurisdiction appears in Section 4.8.1.1 of this SEIS. The NRC staff concludes that the proposed action would have no adverse effects on Essential Fish Habitat. The NRC staff's evaluation of impacts to Essential Fish Habitat appears in Section 4.8.1.2 of this SEIS. The NRC staff concludes that the proposed action would not affect the sanctuary resources of the Florida Keys National Marine Sanctuary. The NRC staff's evaluation of sanctuary resources appears in Section 4.8.1.3 of this SEIS.

[d] This issue was not designated as Category 1 or Category 2 and is discussed in Section 4.11.1, "Proposed Action."

Source: Table B-1 in Appendix B, Subpart A, to 10 CFR Part 51 and NRC 2013a

4.2 Land Use and Visual Resources

This section describes the potential land use and visual resources impacts of the proposed action (subsequent license renewal) and alternatives to the proposed action.

4.2.1 Proposed Action

According to the GEIS (NRC 1996 and NRC 2013a), land use and visual resources would not be affected by continued operations and refurbishment associated with license renewal. In addition, nuclear plant operations at Turkey Point have not changed appreciably with time, and no change in land use and visual resources impacts are expected during the subsequent license renewal term. The NRC staff identified no new or significant information for these issues.

In this regard, no new or significant information was identified during the review of FPL's environmental report, the NRC staff's site visit, the scoping process, or the evaluation of other available information. The communities in the vicinity of Turkey Point have pre-established patterns of development and have adequate public services to support and guide development. Consequently, people living in the vicinity of Turkey Point would not experience any land use or visual changes during the subsequent license renewal term beyond what has already been experienced. In addition, no adverse effects on offsite land use will occur related to the Everglades Restoration Project (conducted under the Comprehensive Everglades Restoration Plan (CERP)) or other Federal action in the proposed project area. Therefore, the land use and visual impacts of continued reactor operations during the subsequent license renewal term would not exceed the land use and visual impacts predicted in the GEIS. For these issues, the GEIS predicted that the impacts would be SMALL for all nuclear plants.

As identified in Table 4-1, the impacts of all generic land use or visual resource issues would be SMALL. Table 4-2 does not identify any site-specific (Category 2) land use or visual resource issues.

4.2.2 No-Action Alternative

4.2.2.1 Land Use

Under the no-action alternative, the NRC would not issue subsequent renewed licenses, and Turkey Point Units 3 and 4 would shut down on or before the expiration of the current renewed operating licenses (i.e., 2032 and 2033). Under this alternative, land uses would remain similar to those that would occur under the proposed subsequent license renewal except that land could be converted to other uses sooner if Turkey Point is shut down in 2032 and 2033 instead of operating for an additional 20 years. Shutdown of Turkey Point under the no-action alternative thus would not affect onsite land use. Plant structures and other facilities would remain in place until decommissioning. Most transmission lines would remain in service after the plant stops operating. Maintenance of most existing infrastructure would continue as before. Therefore, land use impacts from the termination of Turkey Point Unit Nos. 3 and 4 nuclear plant operations would be SMALL.

4.2.2.2 Visual Resources

Shutdown of Turkey Point under the no-action alternative would not significantly change the visual appearance of the Turkey Point site. At the Turkey Point site, the reactor and turbine buildings are the buildings that create the largest visual impact. Under the no-action alternative, the reactor and turbine buildings would likely remain in place for some time but would eventually be dismantled. This would reduce the visual impact. Overall, visual impacts from the termination of Turkey Point Unit Nos. 3 and 4 nuclear plant operations would be SMALL.

4.2.3 Replacement Power Alternatives: Common Impacts

4.2.3.1 Land Use

The NRC staff's analysis of land use impacts focuses on the amount of land area that would be affected by the construction and operation of a replacement power plant.

Construction

Construction would require the permanent commitment of land zoned for industrial use at the Turkey Point site for replacement power plants and associated infrastructure. Existing Turkey Point transmission lines and infrastructure would adequately support each of the replacement power alternatives, thus reducing the need for additional land commitments.

Operations

Operation of new power plants would have no land use impacts beyond land committed for the permanent use of the replacement power plant. Additional land may be required to support power plant operations including land for mining, extraction, and waste disposal activities associated with each alternative.

4.2.3.2 Visual Resources

The NRC staff's visual impact analysis focuses on the degree of contrast between the replacement power plant and the surrounding landscape and the visibility of the new power plant.

Construction

Land for any replacement power plant would require clearing, excavation, and the use of construction equipment. Temporary visual impacts may occur during construction from cranes and other construction equipment.

Operations

Visual impacts during plant operations of any of the replacement power alternatives would be similar in type and magnitude. New cooling towers (if built) and their associated plumes would be the most obvious visual impact and would likely be visible farther from the site than other buildings and infrastructure. New plant stacks may require aircraft warning lights, which would be visible at night.

4.2.4 New Nuclear Alternative

4.2.4.1 Land Use

Construction

Approximately 360 acres (ac) (150 hectares (ha)) of land would be needed to construct a new nuclear power plant. Although there is sufficient land available at the Turkey Point site, some wetlands may be temporarily displaced during construction. Land use impacts during construction would be SMALL at the Turkey Point site since the land is already zoned for industrial use.

Operations

Offsite land use impacts associated with uranium mining and fuel fabrication needed to support nuclear power plant operations would generally be no different from the amount of land needed to support Turkey Point Units 3 and 4 operations, although more land would be required for mining additional uranium for up to 40 years of operation. Based on this information, onsite and offsite land use impacts from constructing and operating a new nuclear power plant could range from SMALL to MODERATE depending on how much additional land may be needed for uranium mining and fuel fabrication.

4.2.4.2 Visual Resources

Construction and Operations

Visual impacts from a new nuclear alternative would be similar to the common impacts of all replacement power alternatives described in Section 4.2.3.2, "Visual Resources." The visual appearance of the power block for the new nuclear power plant would be virtually identical to the existing Turkey Point Units 3 and 4 power blocks. Mechanical draft cooling towers and associated condensate plumes would add to the visual impact. However, the height of the mechanical draft cooling towers would not likely exceed those of other buildings at the Turkey Point site. Therefore, visual impacts during the construction and operation of a new nuclear power plant at the Turkey Point site, including steam plumes that could be visible from great distances, could range from SMALL to MODERATE depending on seasonal weather conditions.

4.2.5 Natural Gas Combined-Cycle Alternative

4.2.5.1 Land Use

Construction

The natural gas combined-cycle (NGCC or natural gas) power plant would require 75 ac (30 ha) of land with up to an additional 1,200 ac (490 ha) needed for right-of-way to connect with existing natural gas supply lines located approximately 100 miles (mi) (161 kilometers (km)) north of the Turkey Point site. No new gas wells would be needed to support a natural gas power plant (FPL 2018f). This land use impact would be partially offset by the elimination of land used for uranium mining to supply fuel to Turkey Point Units 3 and 4. Land use impacts caused by uranium mining and natural gas extraction and collection are described in Section 4.15.1, "Fuel Cycle."

Constructing the natural gas power plant at the Turkey Point site would make use of available infrastructure. In addition, the land is already zoned for industrial use. However, some natural areas could be converted to industrial use if portions of the new power plant are built outside the existing industrial footprint. Although this use of the land would be noticeable, construction would not likely destabilize adjacent land use, due to the current industrial nature of the Turkey Point site. Accordingly, construction impacts could have SMALL to MODERATE land use impacts. This is primarily due to the amount of non-industrially zoned land that could be affected by this alternative.

Operations

Operation of a natural gas power plant would not cause any additional land use changes; therefore, land use impacts during operations would be SMALL. Overall land use impacts of the natural gas combined-cycle alternative, including both construction and operation, would therefore range from SMALL to MODERATE.

4.2.5.2 Visual Resources

Construction and Operations

Visual impacts from a natural gas power plant would be similar to the description in Section 4.2.3.2, "Visual Resources," for the common impacts from all replacement power alternatives. However, construction and operation of the natural gas power plant would have little to no additional visual impact. The height of the mechanical draft cooling towers would not likely exceed those of other buildings at the Turkey Point site. Therefore, visual impacts during the construction and operation of a new NGCC facility at the Turkey Point site, including steam plumes that could be visible from great distances, could range from SMALL to MODERATE depending on seasonal weather conditions.

4.2.6 Combination Alternative (Natural Gas Combined-Cycle and Solar Photovoltaic Generation)

4.2.6.1 Land Use

<u>Construction and Operations</u>

The natural gas power plant component of the combination alternative would require somewhat less land than the full-scale natural gas power plant described in Section 4.2.5.1. The natural gas power plant component would require 70 ac (28 ha) of land with up to an additional 1,200 ac (490 ha) needed for right-of-way to connect with existing natural gas supply lines located approximately 100 mi (161 km) north of the Turkey Point site. No new gas wells would be needed to support a natural gas power plant (FPL 2018f). Accordingly, land use impacts would be similar to or less than those described for the full-scale natural gas power plant alternative. However, the impacts could still range from SMALL to MODERATE.

A utility-scale solar photovoltaic (solar) facility would require approximately 470 ac (190 ha) of cleared land for the three proposed offsite solar power installations (FPL 2018f). Standalone solar facilities cannot be collocated with other land uses (such as grazing and crop-producing agricultural fields). Land use impacts would range from MODERATE to LARGE, depending on the amount and types of land uses that would be affected by construction of the four solar facilities.

Overall land use impacts of this combination natural gas and solar alternative would therefore range from SMALL to LARGE. This is primarily due to the amount and types of land uses that would be affected by the solar facilities.

4.2.6.2 Visual Resources

<u>Construction and Operations</u>

Visual impacts from the combination natural gas and solar alternative would be similar to the common impacts described in Section 4.2.3.2, “Visual Resources,” for all replacement alternatives. However, construction and operation of the natural gas power plant would have little to no additional visual impact. The height of the mechanical draft cooling towers would likely not exceed those of other buildings at the Turkey Point site. Visual impacts of the natural gas component would be similar to the impacts described in Section 4.2.5.2.

The visual impacts of the solar components of this alternative would vary, depending on location and topography. Depending on the location, standalone solar facilities could have a MODERATE to LARGE visual impact. Visual resource impacts of the combination alternative could therefore range from SMALL to LARGE. This range is primarily due to the potential visual impacts from the solar photovoltaic components of this alternative.

4.2.7 Cooling Water System Alternative

4.2.7.1 Land Use

Construction and Operations

Construction of two mechanical draft cooling towers for a cooling water system alternative could require the relocation of existing support activities at the Turkey Point site. Because only previously disturbed industrial portions of the Turkey Point site would be used to accommodate the new cooling towers, land use impacts associated with the construction and operation of the mechanical draft cooling towers for the cooling water system alternative would be SMALL.

4.2.7.2 Visual Resources

Construction and Operations

Construction and operation of the two cooling towers for a cooling water system alternative would have little to no additional visual impact. The height of the mechanical draft cooling towers would be similar to the height of other buildings at the Turkey Point site. Temporary visual impacts may occur during construction from cranes and other construction equipment. During facility operations, cooling tower steam plumes could add to the existing visual impact. Therefore, visual impacts during the construction and operation of two new cooling towers at the Turkey Point site, including steam plumes that could be visible from great distances, could range from SMALL to MODERATE depending on seasonal weather conditions.

4.3 Air Quality and Noise

This section describes the potential air quality and noise impacts of the proposed action (subsequent license renewal) and alternatives to the proposed action.

4.3.1 Proposed Action

4.3.1.1 Air Quality

According to the GEIS (NRC 1996 and NRC 2013a), the generic issues related to air quality as identified in Table 4-1 above would not be affected by continued operations associated with license renewal. As discussed in Chapter 3, the NRC staff identified no new and significant information for these issues. Thus, as concluded in the GEIS, the impacts of those generic issues related to air quality would be SMALL. Table 4-2 does not identify any site-specific (Category 2) air quality issues for Turkey Point Units 3 and 4.

4.3.1.2 Noise

According to the GEIS (NRC 1996 and NRC 2013a), noise has not been found to be a problem at operating plants and is not expected to be a problem at any plant during the subsequent license renewal term. In addition, nuclear plant operations at Turkey Point Units 3 and 4 have not changed appreciably with time, and no change in noise levels or noise-related impacts are expected during the subsequent license renewal term.

The NRC staff identified no new or significant information during its review of the FPL environmental report, at the site visit, through the scoping process, or in the evaluation of other available information. Consequently, people living in the vicinity of Turkey Point Units 3 and 4 would not experience any changes in noise levels during the subsequent license renewal term beyond what is currently being experienced. Therefore, the impact of continued reactor operations during the subsequent license renewal term would not exceed the noise impacts predicted in the GEIS. For these issues, the GEIS predicts that noise impacts would be SMALL for all nuclear plants.

As identified in Table 4-1, the impacts of all generic noise issues would be SMALL. Table 4-2 does not identify any site-specific (Category 2) noise issues for Turkey Point Units 3 and 4.

4.3.2 No-Action Alternative

4.3.2.1 Air Quality

Under the no-action alternative, there would be a reduction in air pollutant emissions from activities related to the cessation of Turkey Point operations, such as the use of combustion sources (diesel generators, engines) and vehicle traffic. Activity from these air emission sources would not cease, but emissions would be lower. Therefore, the NRC staff concludes that if emissions decrease, the impact on air quality from the shutdown of Turkey Point would be SMALL

4.3.2.2 Noise

Under the no-action alternative, the NRC would not issue subsequent renewed licenses, and reactor operations at Turkey Point Units 3 and 4 would shut down on or before the expiration of the current renewed operating licenses. The termination of reactor operations would result in a reduction in noise sources throughout the nuclear facility, including noise from turbine generators, machinery, pumps, and other noise-generating equipment, and some vehicular traffic. Therefore, noise impacts resulting from the no-action alternative would be SMALL.

4.3.3 Replacement Power Alternatives: Common Impacts

4.3.3.1 Air Quality

<u>Construction</u>

Construction of a power station under a replacement power alternative would result in temporary impacts on local air quality. Air emissions would be intermittent and would vary based on the level and duration of specific activities throughout the construction phase. During the construction phase, the primary sources of air emissions would consist of engine exhaust and fugitive dust emissions. Engine exhaust emissions would be from heavy construction equipment and commuter, delivery, and support vehicular traffic traveling to and from the facility as well as within the site. Fugitive dust emissions would be from soil disturbances by heavy construction equipment (e.g., earthmoving, excavating, and bulldozing), vehicle traffic on unpaved surfaces, concrete batch plant operations, and wind erosion to a lesser extent. Various mitigation techniques and best management practices (e.g., watering disturbed areas, reducing equipment idle times, and using ultra-low sulfur diesel fuel) could be used to minimize air emissions and to reduce fugitive dust. Implementation of a dust-control plan would also address reasonable precautions that would be needed to prevent fugitive particulate emissions in accordance with Florida Administrative Code 62-296.320(4)(c)3. Air emissions include criteria pollutants (particulate matter, nitrogen oxides, carbon monoxide, and sulfur dioxide), volatile organic compounds, hazardous air pollutants, and greenhouse gases (GHGs). Small quantities of volatile organic compounds and hazardous air pollutants would also be released from equipment refueling, onsite maintenance of the heavy construction equipment, and other construction finishing activities as well as from cleaning products, petroleum-based fuels, and certain paints.

Operations

The impacts on air quality as a result of operation of a power station for a replacement power alternative will depend on the energy technology (i.e., fossil-fuel based or nuclear). Fossil fuel-based power plants result in larger amounts of air emissions than nuclear power plants. Worker vehicles, auxiliary power equipment, and mechanical draft cooling tower operation will result in additional air emissions.

4.3.3.2 Noise

Construction

Noise levels during the construction of a replacement power facility would be similar to noise levels during the construction of any industrial facility in that all involve many noise-generating activities. In general, noise emissions would be temporary and noise levels would vary during each phase of construction, depending on the amount of activity, types of equipment and machinery used, and site-specific conditions. Typical construction equipment, such as dump trucks, loaders, bulldozers, graders, scrapers, air compressors, generators, and mobile cranes, would be used, and pile-driving and blasting activities could take place. Other noise sources include construction worker vehicle and truck delivery traffic. However, noise from vehicular traffic would be intermittent and would generate noise at levels similar to noise levels from Turkey Point Units 3 and 4 reactor operations.

Operations

Noise generated during operations could include noise from mechanical draft cooling towers, transformers, turbines, machinery, equipment, and communication announcements and sirens, as well as offsite sources, such as employee and delivery vehicular traffic. Noise from vehicles would be intermittent and at levels similar to noise levels generated by vehicles at Turkey Point. Similarly, with the exception of noise from mechanical draft cooling towers, operational noise levels at a replacement power plant would likely be similar to existing noise levels at Turkey Point Units 3 and 4.

4.3.4 New Nuclear Alternative

4.3.4.1 Air Quality

Construction

Air emissions and sources associated with construction of the new nuclear alternative would include those identified as common to all replacement power alternatives in Section 4.3.3.1, “Air Quality.” Because air emissions from construction activities would be limited, local, and temporary, the NRC staff concludes that the associated air quality impacts from construction of a new nuclear alternative would be SMALL.

Operations

Operation of a new nuclear generating plant would result in air emissions similar in magnitude to air emissions from the operation of Turkey Point. Sources of air emissions would include stationary combustion sources (e.g., diesel generators, auxiliary boilers, and fire pumps) and mobile sources (e.g., worker vehicles, onsite heavy equipment, and support vehicles). Additional air emissions would result from the new nuclear plant's use of mechanical draft cooling towers rather than the cooling canal system currently used by Turkey Point and could contribute to impacts associated with the formation of visible plumes, fogging, and subsequent icing downwind of the towers. In general, most stationary combustion sources at a nuclear power plant would operate only for limited periods, often during periodic maintenance testing. A new nuclear power plant would need to secure a permit from the Florida Department of Environmental Protection (FDEP) for air pollutants associated with its operations (e.g., criteria pollutants, volatile organic compounds, hazardous air pollutants, and greenhouse gases). The NRC staff expects the air emissions for combustion sources from a new nuclear plant to be similar to those currently being emitted from Turkey Point Units 3 and 4 (see Section 3.2.1). Emissions from the mechanical draft cooling towers would be approximately 15 tons/year for particulate matter less than 10 microns and 0.08 tons/year for particulate matter less than 2.5 microns (NRC 2016a). Therefore, the NRC staff expects that the combined air quality impact of emissions from onsite sources would be minor. Additional air emissions would result from the approximately 800 employees commuting to and from the new nuclear facility. The NRC staff does not expect air emissions from operation of a new nuclear alternative to contribute to National Ambient Air Quality Standard violations. The NRC staff concludes that the impacts of operation of a new nuclear alternative on air quality would be SMALL.

4.3.4.2 Noise

Construction

Noise generated during the construction and operation of a new nuclear power plant would be similar to noise for all replacement power alternatives as discussed in Section 4.3.3.2, "Noise." In addition, Sections 4.8.2 and 5.8.2 of the EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG-2176) (NRC 2016a) describe noise impacts generated during construction and operation of proposed Turkey Point Units 6 and 7; those noise impacts would be similar to the noise impacts of constructing and operating new nuclear plants to replace Units 3 and 4. Accordingly, the NRC staff incorporates the information in Sections 4.8.2 and 5.8.2 of NUREG-2176 here by reference (NRC 2016a). Noise impacts during construction would be limited to the immediate vicinity of the Turkey Point site. Because of the distance of the site to potential receptors, noise impacts during the construction of a new nuclear power facility at the Turkey Point site could range from SMALL to MODERATE depending on the noise-sensitive receptor.

Operations

Mechanical draft cooling towers generate noise during operations. Other sources of noise during nuclear power plant operations would include industrial equipment, machinery, vehicles, and communications. In general, noise would be limited to the immediate vicinity of the Turkey Point site and, with the exception of the cooling towers, noise levels would be similar to noise levels generated during the operation of Turkey Point Units 3 and 4. Therefore, noise impacts during power plant operations for a new nuclear plant would be SMALL.

4.3.5 Natural Gas Combined-Cycle Alternative

4.3.5.1 Air Quality

Construction

Air emissions and sources associated with construction of the natural gas alternative would include those identified as common to all replacement power alternatives in Section 4.3.3.1, "Air Quality." There would also be additional air emissions resulting from construction of a new or upgraded pipeline that would connect to existing natural gas supply lines north of the site. Air emissions would be localized, intermittent, and short lived, and adherence to well-developed and well-understood construction best management practices would mitigate air quality impacts. Therefore, the NRC staff concludes that construction-related impacts on air quality from a natural gas alternative would be of relatively short duration and would be SMALL.

Operations

Operation of a natural gas plant would result in emissions of criteria pollutants and greenhouse gases. The sources of air emissions during operation include gas turbines through heat recovery steam generator stacks. The staff estimated air emissions for the natural gas alternative using emission factors developed by the U.S. Department of Energy's (DOE) National Energy Technology Laboratory (NETL 2012). Assuming a total gross capacity of 1,726 MW and a capacity factor of 0.87 (FPL 2018f), the NRC staff estimates the following air emissions would result from operation of a natural gas alternative:

- sulfur oxides—20 tons (18 metric tons (MT)) per year
- nitrogen oxides—440 tons (400 MT) per year
- carbon monoxide—45 tons (41 MT) per year
- PM_{10}—32 tons (29 MT) per year
- carbon dioxide equivalents (CO_{2eq})—5.7 million tons (5.2 million MT) per year

Operation of the mechanical draft cooling towers and up to 150 worker vehicles would also result in additional criteria emissions above those presented in the list. A new natural gas plant would qualify as a major emitting industrial facility. As such, the new natural gas plant would be subject to Prevention of Significant Deterioration (PSD) and Title V air permitting requirements under the Clean Air Act of 1970, as amended (42 U.S.C. 7651 et seq.), to ensure that air emissions are minimized and that the local air quality is not substantially degraded. Additionally, various Federal and State regulations aimed at controlling air pollution would affect a natural gas alternative.

Based on the NRC staff's air emission estimates, nitrogen oxide and greenhouse gas emissions from a natural gas plant would be noticeable and significant. Carbon dioxide emissions would be much larger than the threshold in the U.S. Environmental Protection Agency's (EPA's) Greenhouse Gas Tailoring Rule, and nitrogen oxide emissions would exceed the threshold for major sources. The NRC staff concludes that the overall air quality impacts associated with operation of a natural gas alternative would be SMALL to MODERATE.

4.3.5.2 Noise

Construction

In addition to the common impacts discussed in Section 4.3.3.2, "Noise," for all replacement power alternatives, additional noise would be generated during the construction of pipelines to support a natural gas power plant. Because of the distance involved in pipeline construction, noise impacts during the construction of a natural gas power plant and gas pipeline could range from SMALL to MODERATE depending on the location of noise-sensitive receptors along the gas pipeline.

Operations

Noise generated during the operation of a natural gas power plant would include noise from mechanical draft cooling towers, compressor stations, and pipeline blowdowns. However, the majority of noise-producing equipment (e.g., mechanical draft cooling towers, turbines, pumps) would be located inside the power block. Therefore, noise impacts during power plant operations would be SMALL.

4.3.6 Combination Alternative (Natural Gas Combined-Cycle and Solar Photovoltaic Generation)

4.3.6.1 Air Quality

Construction

Air emissions and sources associated with construction of both the natural gas and solar portions of this combination alternative would include those identified as common to all replacement power alternatives in Section 4.3.3.1, "Air Quality." Air emissions from construction would be localized and intermittent, and well-understood construction best management practices would mitigate air quality impacts. Therefore, the NRC staff concludes that construction-related impacts on air quality from the combination alternative would be SMALL.

Operations

Air emissions associated with the operation of the natural gas portion of the combination alternative would be similar to those associated with the natural gas alternative. However, emissions associated with the natural gas portion of the combination alternative are slightly reduced because the electricity output of the natural gas unit under the combination alternative would be approximately 95 percent of that of the natural gas-only alternative.

The NRC staff estimates the following air emissions for the natural gas portion of the combination alternative based on emission factors developed by the DOE's National Energy Technology Laboratory (NETL 2012):

- sulfur oxides—19 tons (18 metric tons (MT)) per year
- nitrogen oxides—420 tons (380 MT) per year
- carbon monoxide—43 tons (39 MT) per year
- PM_{10}—30 tons (28 MT) per year
- carbon dioxide equivalents (CO_{2eq})—5.4 million tons (4.9 million MT) per year

Operation of the mechanical draft cooling towers and up to 150 worker vehicles would also result in additional criteria emissions above those presented in the list. The new natural gas units would qualify as major emitting industrial facilities and would be subject to Prevention of Significant Deterioration and Title V air permitting programs aimed at controlling air pollution. Carbon dioxide emissions would be greater than the threshold in EPA's Greenhouse Gas Tailoring Rule, and nitrogen oxide and carbon monoxide emissions would exceed the threshold for major sources.

Air emissions associated with the operation of solar energy facilities are negligible because no fossil fuels are burned to generate electricity. Emissions from solar fields would include fugitive dust and engine exhaust emissions from vehicles and heavy equipment associated with site inspections, maintenance activities (panel washing or replacement), and wind erosion from cleared lands and access roads. The types of emission sources and pollutants during operation would be similar to those during construction, but much fewer emissions would be released during operation. These emissions should not cause exceedances of air quality standards or have any impacts on climate change. The NRC staff concludes that the overall air quality impacts associated with operation of the combination alternative would be SMALL to MODERATE.

4.3.6.2 Noise

Construction

Construction-related noise sources for the natural gas power plant portion of the combination alternative would be similar to the impacts discussed for the natural gas-only power plant alternative in Section 4.3.5.2, "Noise," and the common impacts discussed in Section 4.3.3.2, "Noise," for all replacement power alternatives. Noise impacts during the construction of a solar facility could range from SMALL to MODERATE depending on its location in proximity to noise-sensitive receptors. Therefore, construction impacts from the combination alternative could range from SMALL to MODERATE depending on the location of noise-sensitive receptors.

Operations

Noise generated during natural gas power plant operations would include noise from mechanical draft cooling towers, compressor stations, and pipeline blowdowns. Noise impacts during operation of the natural gas power plant component of the combination alternative would be similar to those described in Section 4.3.5.2. Except for maintenance activities, very little noise would be generated by the solar facility. Therefore, noise impacts during facility operations from the combination alternative would be SMALL.

4.3.7 Cooling Water System Alternative

4.3.7.1 Air Quality

Construction and Operations

Under the cooling water system alternative, three plume-abated wet mechanical draft cooling towers would be constructed for each reactor unit. Air emissions from construction of the cooling towers would result from the exhaust of construction equipment, worker vehicle exhaust, land disturbance activities (land-clearing, excavation), and demolition activities. Fuel combustion exhaust would emit criteria pollutants and greenhouse gases while land-disturbance and demolition activities would result in fugitive dust.

Potential atmospheric impacts from cooling system operation include the formation of visible plume, fogging, and subsequent icing downwind of the towers. Operation of cooling towers would also result in the emission of particulate matter from cooling tower drift, with higher concentrations of dissolved solids associated with the potential use of seawater as a secondary source of cooling water. However, modern cooling towers equipped with drift eliminators would minimize the loss of water from the cooling towers via drift. As stated in Section 5.7.2 of the final EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG-2176), cooling tower emissions would be required to adhere to the New Source Performance Standards (40 CFR 60.40, “Applicability and Designation of Affected Facility”) and demonstrate compliance with ambient air-quality standards by acquiring a Prevention of Significant Deterioration permit under the Clean Air Act before the cooling towers could be operated (NRC 2016a).

Replacement power would be needed during both construction and operation of a mechanical draft cooling tower system at Turkey Point. Construction-related outages may result from necessary modifications to the facility. Following cooling tower construction, Turkey Point Units 3 and 4 would be offline for at least a short time during the switchover from use of the cooling canal system (CCS) to cooling towers. Therefore, during these periods, additional power would be needed to replace the generating capacity of Turkey Point Units 3 and 4. Some replacement power could also be required once Turkey Point’s cooling tower system is online to compensate for the additional power needed to operate cooling tower pumps and fans. Replacement power would likely come from common types of existing technology within the region (natural gas, nuclear, or coal), but it is not likely that new facilities would be constructed. The impacts on air quality would depend on the specific location and technology of the replacement power facilities.

In Sections 4.7 and 5.7 of the final EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG-2176), the NRC staff determined that air impacts from the construction and operation of Units 6 and 7, including those associated with the construction and operation of the mechanical draft cooling towers, would be SMALL (NRC 2016a). As described in Section 2.2.3, “Cooling Water System Alternative,” of this SEIS, construction and operation of mechanical draft cooling towers for Units 3 and 4 would be similar to, but proportionally smaller than, the impacts described in the NUREG-2176 analysis for Units 6 and 7. Therefore, the NRC staff concludes that the air quality impacts from the construction and operation of mechanical draft cooling towers to support Turkey Point Units 3 and 4 would be SMALL.

4.3.7.2 Noise

<u>Construction</u>

Construction-related noise during construction of the cooling towers for the cooling water system alternative would be similar to the impacts discussed in Section 4.3.3.2, “Noise,” as common to all replacement power alternatives. Because of the distance from the site to noise-sensitive receptors, noise impacts during construction of the cooling towers for the cooling water system alternative at the Turkey Point site could range from SMALL to MODERATE depending on the noise-sensitive receptor.

Operations

As previously discussed, mechanical draft cooling towers generate noise during operations. In general, noise impacts when the cooling towers for the cooling water system alternative are operating would be limited to the immediate vicinity of the Turkey Point site and would be SMALL.

4.4 Geologic Environment

This section describes the potential geology and soil resource impacts of the proposed action (subsequent license renewal) and alternatives to the proposed action.

4.4.1 Proposed Action

According to the 2013 GEIS (NRC 2013a), plant-specific environmental reviews conducted by the NRC had not identified any significant impact issues related to geology and soil resources. The NRC staff's review of the Turkey Point subsequent license renewal application has not identified any new or significant information that would change the conclusion in the GEIS. Thus, as concluded in the GEIS, the impacts of continued operation on geology and soil resources would be SMALL.

As identified in Table 4-1, the impacts of the single geologic environment issue (geology and soils) would be SMALL. Table 4-2 does not identify any site-specific (Category 2) geologic environment issues.

4.4.2 No-Action Alternative

Under the no-action alternative, the NRC would not issue subsequent renewed licenses and Turkey Point Units 3 and 4 would shut down on or before the expiration of the current renewed licenses. There would not be any impacts to the geology and soils at the Turkey Point site with the shutdown of the facility. With the shutdown of the facility, no additional land would be disturbed. Therefore, the NRC staff concludes that impacts on geology and soil resources from the no-action alternative would be SMALL.

4.4.3 Replacement Power Alternatives: Common Impacts

Under all replacement power alternatives, construction impacts would be temporary and localized. During construction for all the replacement power alternatives, sources of aggregate material (such as crushed stone, sand, and gravel) would be required to construct buildings, foundations, roads, and parking lots. The NRC staff presumes that these resources would likely be obtained from commercial suppliers using local or regional sources.

During construction of all replacement power alternatives, no previously undisturbed soils would be impacted. Organic soil or "muck" on the proposed building site would be removed and disposed of in several locations on the berms alongside the main return canal and southern canal of the CCS (also called the industrial wastewater facility). Prior to placement of spoils material, part of the surface would be excavated, and small containment berms would be created to form a shallow excavation in which to place the spoils. Material that is removed from the excavations and is not suitable for reuse would be placed in these areas for dewatering and disposal. FPL has indicated that measures such as berms, riprap, sedimentation filters, and detention ponds would be used to control drainage from the spoils piles to the CCS (NRC 2016a).

During operation of replacement power alternatives, no additional land would be disturbed. Therefore, NRC staff concludes that the common impacts of operations of replacement power alternatives on geology and soil resources would be SMALL.

4.4.4 New Nuclear Alternative

The NRC staff did not identify any impacts to the geologic environment for the new nuclear alternative beyond those discussed above as common to all replacement power alternatives. Therefore, the NRC staff concludes that the impacts to geology and soil resources from the new nuclear alternative would be SMALL.

4.4.5 Natural Gas Combined-Cycle Alternative

The NRC staff did not identify any impacts to the geologic environment for the natural gas alternative beyond those discussed above as common to all replacement power alternatives. Therefore, the NRC staff concludes that the impacts to geology and soil resources from the natural gas alternative would be SMALL.

4.4.6 Combination Natural Gas Combined-Cycle and Solar Photovoltaic Alternative

For the natural gas component of this alternative, the NRC staff did not identify any impacts to the geologic environment beyond those discussed above as common to all replacement power alternatives. However, the solar component of this alternative would require land to be cleared for solar power installations. The corresponding impacts on soil resources would be noticeable, but they would not destabilize important attributes of the resource. Therefore, the NRC staff concludes that the impacts to geology and soil resources from the combination natural gas and solar alternative would be MODERATE.

4.4.7 Cooling Water System Alternative

The NRC staff did not identify any impacts to the geologic environment for the cooling water system alternative beyond those discussed above as common to all replacement power alternatives. Therefore, the NRC staff concludes that the impacts to geology and soil resources from the cooling water system alternative would be SMALL.

4.5 <u>Water Resources</u>

This section describes the potential surface water and groundwater resources impacts of the proposed action (subsequent license renewal) and alternatives to the proposed action.

4.5.1 Proposed Action

4.5.1.1 Surface Water Resources

According to the GEIS (NRC 1996 and NRC 2013a), for the most part, no significant surface water impacts for Category 1 (generic) issues are anticipated during the license renewal term that would be different from those occurring during the current license term. The NRC staff's review of the Turkey Point SLR application has not identified any new and significant information that would change the conclusion in the GEIS. Thus, as concluded in the GEIS, for these Category 1 (generic) issues, the impacts of continued operation on surface water resources would be SMALL.

Table 4-1 in Section 4.1 lists "Applicable Category 1 (Generic) Issues for Turkey Point." The impacts for these issues are SMALL. While no Category 2 (site-specific) issues applicable to the Turkey Point site have been identified, the NRC staff did evaluate the significance of new information for the impacts from the CCS on adjacent surface water bodies via the groundwater pathway. As discussed below, this information was determined not to be significant for Turkey Point subsequent license renewal.

<u>New Issue, Water Quality Impacts on Adjacent Water Bodies (Plants with Cooling Ponds in Salt Marshes)</u>

As part of its review of the Turkey Point subsequent license renewal application, the NRC staff identified new information regarding nuclear power plant operations that can act upon the environment in a manner or in an intensity or scope (context) not previously recognized. Specifically, the GEIS (NUREG–1437) did not consider how a nuclear power plant with a cooling pond in a salt marsh may indirectly impact the water quality of adjacent surface water bodies via a groundwater pathway. This constitutes a new, site-specific issue with respect to Turkey Point, for which the NRC staff has prepared the following site-specific analysis.

In its environmental report, FPL identified the Category 1 issue, "Altered salinity gradients," as applicable to Turkey Point Units 3 and 4 operations. However, the NRC staff has determined that this issue is not applicable to Turkey Point due to the unique configuration of the Turkey Point CCS. As indicated in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 and as further described in the GEIS (NRC 2013a), the issue, "Altered salinity gradients," only applies to nuclear power plants located on estuaries and changes in salinity due to the operational effects of intake and discharge structures in estuaries. At Turkey Point, the intake and discharge structures associated with Units 3 and 4 are located within the enclosed CCS, which does not directly discharge to the surface waters of Biscayne Bay. Nonetheless, the NRC staff has evaluated new and potentially significant information related to the operation of the CCS and its effects on salinity within the Biscayne aquifer under the issue, "Groundwater quality degradation (plants with cooling ponds in salt marshes)," in Section 4.5.1.2 of this SEIS rather than under the new issue discussed in this section.

For this new issue (water quality impacts on adjacent water bodies), Sections 3.1.3, "Cooling and Auxiliary Water Systems," and 3.5.1, "Surface Water Resources," of this SEIS present relevant new information related to the water quality of surface waters adjacent to Turkey Point and the Turkey Point site. Much of this information did not become available until many years after the NRC had issued the initial renewed licenses for Units 3 and 4 in 2002 and was not available at the time that the 2013 GEIS was prepared. The following discussion is based on information summarized in the aforementioned sections of this SEIS.

Turkey Point Units 3 and 4 do not consume surface water or discharge directly to natural surface water bodies. All surface water discharges from Turkey Point flow into the CCS. As described in Section 3.1.3.2 of this SEIS, the CCS is surrounded by perimeter berms that are designed to keep water from entering the CCS. The perimeter berms are built on top of the bedrock, while water levels in the CCS are below the top of the bedrock. The perimeter berms are not in contact with water within the CCS. However, the water in the CCS is in contact with and hydrologically connected to the Biscayne aquifer. The Biscayne aquifer, in turn, is hydrologically connected to the surrounding marsh land, mangrove areas, adjacent drainage canals, Biscayne Bay, and Card Sound.

Water in the CCS is considered industrial wastewater and is not recognized as a usable resource. Therefore, only the impacts from CCS operation on the water quality of adjacent surface water bodies via the groundwater pathway from the CCS through the Biscayne aquifer are considered in this analysis.

The Florida legislature has designated Biscayne Bay and Card Sound, including Biscayne National Park, as "Outstanding Florida Waters." This designation affords these waters the highest water quality protections in the State.

The impact of temperature, salinity, ammonia, and nutrients on water quality has been the focus of CCS operational concerns. It has been reported that increased levels of ammonia, other nutrients, or salinity had been found in local areas adjacent to the CCS, however, as discussed below and in Chapter 3 of this SEIS, discernable effects from CCS derived temperature, ammonia, nutrients, and salinity on Biscayne Bay or Card Sound water qualities has not been detected.

As discussed in Section 3.5.1.4 of this SEIS, ammonia concentrations in the water within the CCS are below the Miami-Dade County ammonia water quality standard. Also as discussed in Section 3.5.1.4, adjacent surface water bodies contain ammonia from natural sources that occur within the water body (e.g., through decay of organic matter). Noticeable concentrations of ammonia have been found in two deep excavations outside of and adjacent to the CCS that contain stagnant water (i.e., the Barge Turning Basin and the remnant canal at Turtle Point). To prevent the movement of ammonia from the CCS into these areas, FPL is undertaking mitigation activities, as discussed below.

Thermal impacts on adjacent water bodies from the CCS have not been detected. Similarly, impacts on surrounding marsh and mangrove areas from CCS contributions of ammonia, nutrients, and salinity have not been detected. Impacts on adjacent canals from CCS contributions of ammonia, nutrients, and salinity have been slight. Water that likely originated from the CCS has sporadically been detected in two canals adjacent to the CCS (the Card Sound remnant canal and the S-20 Canal; see Section 3.5.1.4, "Ammonia and Nutrients and Salinity within Adjacent Canals"). However, the water quality in these two canals has not been degraded sufficiently to prevent these canals from achieving their intended purpose (i.e., transporting fresh water, draining the land, and flood control). Further, little if any influence on surface water quality in Card Sound was detected from the discharge of these two canals into Card Sound.

As described in Section 3.5.2, "Groundwater Resources," hypersaline water originating in the CCS is moving eastward beneath Biscayne Bay at depth along the base of the Biscayne aquifer. Because the hypersaline groundwater is denser than seawater, the hypersaline groundwater is found at the bottom of the Biscayne aquifer and is moving down the eastward dip of the aquifer. Upward movement of this hypersaline water from the Biscayne aquifer and into Biscayne Bay and Card Sound has not been detected in either porewater or shallow monitor well samples collected in the Bay and Sound.

In accordance with agreements reached with and/or requirements imposed by the Florida DEP and Miami-Dade County DERM, FPL is implementing programs to control ammonia and nutrients and to reduce salinities within the CCS. These programs (which include adding fresh or lower salinity water to the CCS, pumping hypersaline water from groundwater, and monitoring and reporting requirements) are expected to reduce the impact of the CCS on groundwater quality within the Biscayne aquifer. In turn, the potential impacts on surface water quality via groundwater from the CCS via the groundwater pathway would also be reduced. These programs are expected to reduce the amount of hypersaline groundwater originating from the CCS. Hypersaline groundwater flow from the CCS beneath Biscayne Bay would, however, continue to move eastward and downgradient along the base of the Biscayne aquifer.

Surface water quality data collected in and around the CCS indicate that CCS impacts on adjacent surface water bodies have been SMALL. CCS impacts on adjacent surface waters remained SMALL even when salinities in the CCS were higher and sometimes much higher than seawater salinities. These impacts remained SMALL even when a seagrass die-off caused nutrients to be released into the CCS. Furthermore, the nutrient and hypersaline water mitigative measures imposed by Florida and Miami-Dade County afford additional confidence that CCS impacts on adjacent surface water bodies will continue to remain SMALL.

For this new site-specific issue, the NRC staff concludes that the impacts on adjacent surface water bodies via the groundwater pathway from the CCS during the subsequent license renewal term would be SMALL and, therefore, the new information that has been identified is not significant.

4.5.1.2 Groundwater Resources

According to the GEIS (NRC 1996 and NRC 2013a), groundwater resources would not be significantly affected by continued operations associated with license renewal in most circumstances. As discussed in Section 3.5.2 of this SEIS, the NRC staff identified no new and significant information for most issues relating to groundwater use and quality. As identified in Table 4-1, the impacts for most applicable generic groundwater resources issues would be SMALL. However, during its review of FPL's environmental report, site visit, scoping process, and evaluation of other available information, the NRC staff identified new information regarding the generic groundwater resource issue of "Groundwater quality degradation (plants with cooling ponds in salt marshes)." The NRC staff's evaluation of the significance of this new information follows in the subsections below.

Additionally, as indicated in the following subsections, the NRC staff reviewed the descriptions of the modeling analyses that were commissioned by FPL and reported in Tetra Tech (2016, 2014b), in connection with the State of Florida's approval of FPL's groundwater withdrawals from the Biscayne and Upper Floridan aquifers, respectively. The NRC staff also reviewed related information contained in State agency files. Based on its review, the NRC staff and its contractors found the modeling to be reasonable with regard to the modeling analyses' overall technical approach and supporting assumptions. The NRC staff recognizes that the State of Florida, and its regulatory agencies, including the FDEP and the South Florida Water Management District (SFWMD), is statutorily responsible to determine the acceptability of the groundwater analyses, and the staff therefore did not conduct a detailed review of the modeling analyses, codes, input files, or calibration data. In its assessment of those analyses, the NRC staff found no reason to question the analyses' acceptability, their reliability in predicting groundwater flow and transport characteristics, or the State agencies' acceptance of those analyses in exercising their regulatory authority.

New Information, Category 1 Issue, Groundwater Quality Degradation (Plants with Cooling Ponds in Salt Marshes)

As referenced in Section 1.4 of this SEIS and as further described in Sections 1.5 and 1.8 of the GEIS (NUREG-1437) (NRC 2013a), no additional site-specific analysis is required by the NRC staff for Category 1 (generic) issues in the SEIS unless new and significant information is identified that would change the conclusions in the GEIS. Where new and significant information has been identified, the NRC staff will reconsider generic impacts in the SEIS.

The Category 1 issue, "Groundwater quality degradation (plants with cooling ponds in salt marshes)," was first evaluated in the 1996 GEIS (NRC 1996) and was reconsidered as part of the update to the GEIS, issued in June 2013 (NRC 2013a).

For the subject issue, the 2013 GEIS (NRC 2013a: 4-50, 4-51) provides the following technical basis with respect to nuclear power plants that use cooling ponds as part of their cooling water system discharge:

> Nuclear plants that use cooling ponds as part of their cooling water system discharge effluent to the pond. The effluent's concentration of contaminants and other solids increases relative to that of the makeup water as it passes through the cooling system. These changes include increased total dissolved solids (or TDS), since they concentrate as a result of evaporation, increased heavy metals (because cooling water contacts the cooling system components), and increased chemical additives to prevent biofouling. Because all the ponds are unlined (NRC 1996), the water discharged to them can interact with the shallow groundwater system and may create a groundwater mound. In this case, groundwater below the pond can flow radially outward, and this groundwater would have some of the characteristics of the cooling system effluent.
>
> In salt marsh locations, the groundwater is naturally brackish (i.e., with a TDS concentration of about 1,000 to more than 10,000 milligrams per liter [mg/L]) and, thus, is already limited in its uses. As such, this issue concerns only the potential for changing the groundwater use category of the underlying shallow and brackish groundwater due to the introduction of cooling water contaminants. Two nuclear plants, South Texas in Texas and Turkey Point in Florida, have cooling systems (man-made cooling pond and cooling canal system, respectively) located relatively near or constructed in salt marshes. Plants relying on brackish water cooling systems would not further degrade the quality of the shallow aquifer relative to its use classification. This is because groundwater quality beneath salt marshes is already too poor for human use (i.e., it is non-potable water) and is only suitable for industrial use.

The NRC staff concluded in the GEIS (NUREG-1437) (NRC 2013a: 4-50, 4-51) that operational impacts from cooling ponds located in salt marshes would have a SMALL impact on groundwater quality, and no new information was identified that would alter this conclusion.

Section 3.5.2.2, "Groundwater Quality," of this SEIS presents and considers in detail relevant new information related to groundwater quality at the Turkey Point site that supports the staff's reconsideration of the generic impacts of the subject issue. This information is summarized below. The CCS used by Turkey Point Units 3 and 4 and other generating facilities at the Turkey Point site is an expansive water body formed by excavation into the marshes and underlying bedrock. Because the CCS is unlined, it is hydraulically connected to the upper Biscayne aquifer, permitting the movement of water between the CCS and the aquifer through the bedrock. Water in the CCS is hypersaline (i.e., the water has a salinity greater than that of natural seawater, with a chloride concentration exceeding 19,000 mg/L). Over the operational life of the CCS, the annual average salinity of the waters within the CCS and the hypersaline groundwater plume beneath it has increased. The existence of a hypersaline plume beneath the CCS was known at the time the NRC staff prepared its SEIS for the initial license renewal for Turkey Point in 2002. At the time, however, and at the time of the 2013 update to the GEIS (NRC 2013a), the potential for the hypersaline plume to migrate down through the Biscayne aquifer and then move laterally beyond the boundaries of the CCS was not known.

Beginning in 2010, FPL initiated an expanded groundwater monitoring program in accordance with State regulatory approvals of the Turkey Point extended power uprate project, to determine the horizontal and vertical effects of CCS water on the environment. Monitoring results demonstrated that CCS operations have impacted groundwater quality in the Biscayne aquifer beyond the boundaries of the CCS and FPL property, both to the west of the site as well as beneath Biscayne Bay to the east of the Turkey Point site. As discussed in Section 3.5.2.2 of this SEIS, "Groundwater Quality" (see "Baseline Groundwater Quality and Changes Attributable to Turkey Point Operations"), the hypersaline plume emanating from the CCS has migrated along the base of the Biscayne aquifer as well as within the intermediate, high-flow zone to the west. As further discussed in Section 3.5.2.2 of this SEIS, the 2018 baseline continuous surface electromagnetic survey results show that the maximum extent of hypersaline groundwater ranges from approximately 1 mi (1.6 km) west of the CCS at the base of the Biscayne aquifer (i.e., at depths of 87 to 99.4 ft (26.5 to 30.3 m)) to about 3 mi (4.8 km) west of the CCS in the intermediate interval at a depth of 47 to 55 ft (14.3 to 16.8 m) below ground surface.

The NRC staff concludes that the contribution of past CCS hypersaline water discharges to offsite groundwater quality degradation is difficult to quantify, in that statements by the State of Florida (FDEP 2014a) and analyses prepared by FPL, as referenced in Section 3.5.2.2 of this SEIS, indicate that saltwater was present as early as the 1940s near the base of the Biscayne aquifer west of the Turkey Point site (i.e., prior to completion of CCS construction in 1973). In addition, groundwater data from the early 1970s supported the determination that non-potable groundwater occurred beneath much of the area now occupied by the CCS and within the deeper portions of the aquifer west of the site. Thus, portions of the Biscayne aquifer to the west of the CCS did not meet Class G-II groundwater criteria (i.e., potable water use, with total dissolved solids (TDS) levels of less than 10,000 mg/L) prior to CCS construction. This earlier groundwater quality degradation is attributable to regional saltwater intrusion, which had already occurred across southeast Miami-Dade County and the Turkey Point site due to historic land use alterations and groundwater withdrawals that induced saltwater migration from east to west along the base of the Biscayne aquifer (FDEP 2014a, NRC 2016a).

However, the fact that CCS operations have measurably degraded groundwater quality beyond the general confines of the CCS structure and Turkey Point site boundaries is generally not in dispute. Furthermore, it is apparent that water from the CCS has migrated to the west and toward areas where groundwater within the Biscayne aquifer is of sufficient quality to support its use as a potable water supply. Vertical trends in monitoring wells for such parameters as chloride, TDS, and tritium concentrations indicate the influence of CCS water in groundwater both to the west and east of the Turkey Point site, as discussed in Section 3.5.2.2 of this SEIS. Consequently, in accordance with regulatory mechanisms imposed by Miami-Dade County

(MDC 2015a) and FDEP (2016a), FPL initiated operation of a groundwater remediation system in May 2018, to intercept, capture, and retract the hypersaline plume within a 10-year timeframe.

Groundwater monitoring results for tritium also indicate that the extent of potential influence of CCS water (based on a tritium concentration of 20 pCi/L or greater as measured near the base of the Biscayne aquifer) extends as far as 4.5 mi (7.2 km) west of the CCS at monitoring well TPGW-7 and approximately 2 mi (3.2 km) east beneath Biscayne Bay (see Figure 3-13 of this SEIS). These monitoring results show that the extent of tritium migration exceeds the extent of the hypersaline plume from the CCS (as noted above, hypersaline water extends out approximately 3.0 mi (4.8 km) west of the CCS boundary). Nonetheless, using 20 pCi/L for tritium as a standard, near monitoring well TPGW-7 to the west of the CCS, Class G-II groundwater criteria are met in the upper part of the Biscayne aquifer with the relatively fresh water band thickening to the west and away from the saltwater interface. This westward boundary (defined by the current estimate of the 20 pCi/L concentration boundary for tritium in groundwater) is approximately 2 mi (3.2 km) southeast of the Newton Wellfield that supplies potable water from the Biscayne aquifer to parts of Miami-Dade County. At no location outside the boundary of the Turkey Point site do tritium levels in groundwater approach the EPA and State primary drinking water standard for tritium (20,000 pCi/L), while the highest tritium levels observed in offsite monitoring wells near the site during the 2018 reporting period (June 1, 2017 through May 31, 2018) are approximately 15 percent of the standard.

Moreover, the northwestern-most boundary of the 20 pCi/L tritium concentration in the vicinity of monitoring well TPGW-7 closely aligns with the current location of the saltwater interface in the Biscayne aquifer in that area, as shown in Figure 3-22 of this SEIS. Both the U.S. Geological Survey (USGS) and FDEP have asserted that hypersaline water from the CCS contributes to the westward migration of the saltwater interface across southeast Miami-Dade County, as referenced in Section 3.5.2.2. Most recently, FPL reported to FDEP on the results of groundwater modeling (Tetra Tech 2018) that was performed using a variable density flow and salinity transport model to allocate relative contributions to the movement of the saltwater interface. The modeling results indicate that the operation of the CCS, in which the salinity exceeds 35 practical salinity units (PSU), is the single largest contributor to changes (movement) in the location of the saltwater interface, as measured by the areal extent of the saltwater interface (see Subsection "Regulatory Developments with Respect to Cooling Canal System Operations and Groundwater Quality" in Section 3.5.2.2).

Based on the information described above, the NRC staff finds that operation of the CCS under hypersaline conditions, and the migration of an associated hypersaline groundwater plume in the Biscayne aquifer, has contributed to the migration of the saltwater interface across portions of southeastern Miami-Dade County, to the west and north of the Turkey Point site.

Hypersaline groundwater containing tritium has migrated beyond the boundaries of the CCS and Turkey Point property at the base of the Biscayne aquifer from Class G-III groundwater (i.e., non-potable groundwater) to the west and to the east beneath Biscayne Bay. As evidenced by elevated levels of tritium, the NRC staff finds that CCS-influenced water has migrated into portions of the Biscayne aquifer that are a potential source of potable water. While the NRC staff also finds that the constituents of concern are not a human health concern at present, the water originating from the CCS has resulted in the degradation of groundwater quality to the west and east of the CCS, at least at the base of the Biscayne aquifer. In addition, as a source of hypersaline water, the discharge of CCS water to the base of the Biscayne aquifer has been and is currently contributing to the migration of the saltwater interface.

These aspects of cooling pond operations and their effects on groundwater quality were not considered in the GEIS as part of the technical basis for the Category 1 issue, "Groundwater quality degradation (plants with cooling ponds in salt marshes)." The NRC staff has determined that this information is new and significant for current operations, but is not significant for the subsequent license renewal term. Based on the information identified, the NRC staff has concluded that the site-specific impacts for this issue at the Turkey Point site are MODERATE for current operations, but will be SMALL during the subsequent license renewal term as a result of ongoing remediation measures and State and county oversight, now in place at Turkey Point. The NRC staff has assigned these significance levels because the plume of hypersaline water from the CCS has measurably altered and degraded groundwater quality in the lower part of the Biscayne aquifer beyond the CCS and Turkey Point property, but hypersalinity is projected to decrease substantially as a result of ongoing remediation efforts.

As previously referenced and as detailed in Section 3.5.2.2, FPL entered into a Consent Agreement (MDC 2015a) with the Miami-Dade County Division of Environmental Resources Management (DERM) in October 2015 and a Consent Order (FDEP 2016a) with the FDEP in June 2016. Both compliance agreements require FPL to take measures to abate hypersaline water discharges from the CCS and to actively remediate the hypersaline groundwater west and north of FPL's property. In accordance with those requirements, FPL completed construction and commenced operation in May 2018 of a Biscayne aquifer recovery well system, to intercept, capture, and retract the hypersaline plume from the CCS to within FPL's property boundary. The South Florida Water Management District (SFWMD) issued FPL a water use individual permit (Permit No. 13-06251-W) in February 2017 for operation of this system (SFWMD 2017a).

In its environmental report, FPL states that groundwater modeling of the operation of its recovery well system predicts that the system will stop the westward migration of the hypersaline plume in 3 years, begin retracting the hypersaline plume in 5 years, and achieve retraction of the hypersaline plume back to the FPL site (i.e., Turkey Point site) boundary within 10 years, as required by the 2016 Consent Order with FDEP (FPL 2018f). As referenced in Permit No. 13-06251-W, the modeling commissioned by FPL to support the design and permitting of the recovery well system consists of a three-dimensional, density-dependent, groundwater flow and saltwater transport model (Tetra Tech 2016). The modeling results for the constructed well system predict retraction of the westward plume with minor aquifer drawdown impacts. Both the 2015 Consent Agreement with the Miami-Dade County DERM (MDC 2015a) and the 2016 Consent Order from the FDEP (2016a) require that FPL monitor the effectiveness of the system and periodically report the results to the agencies. If monitoring analysis shows that the system is not achieving remediation objectives, FPL must develop and submit alternative plans to the agencies. In the SFWMD report included as part of the permit, SFWMD states that system operation should, as part of the extraction of hypersaline groundwater, pull the saltwater interface in the Biscayne aquifer to the east from its current location and increase the amount of fresh groundwater in areas surrounding the CCS (SFWMD 2017a).

Groundwater models are approximations of natural systems and are dependent on a number of input variables based on assumptions regarding present and future environmental conditions. Thus, they entail substantial uncertainty. As discussed in Section 3.5.1.4, "Adjacent Surface Water Quality and Cooling Canal System Operation" ("Application of Numerical Modeling to CCS Salinity Mitigation"), which has been updated in this SEIS, the NRC staff acknowledges that successful remediation of the hypersaline plume emanating from the CCS by means of continued freshening and operation of the recovery well system is predicated on effective salinity management within the CCS. Nonetheless, the effectiveness of the recovery well system in halting and retracting the hypersaline plume is subject to regulatory oversight by FDEP and DERM, and the terms of the 2016 FDEP Consent Order and 2015 DERM Consent Agreement. To date, FPL's salinity management program has been effective in reducing the annual average salinity of the CCS from a high of 82.5 PSU during the period from June 2014 through May 2015 to 49.5 PSU during the period from June 2017 through May 2018 (see Section 3.5.1.4). This has had beneficial groundwater quality impacts by reducing hypersaline groundwater production. Furthermore, FPL's recovery well system status reports and associated groundwater monitoring indicate that the system is reducing the salinity in the shallow (uppermost) interval of the Biscayne aquifer adjacent to the recovery wells. FPL states that the observations to date are consistent with its groundwater modeling projections of system performance (see "Regulatory Developments with Respect to Cooling Canal System Operations and Groundwater Quality" in Section 3.5.2.2).

Therefore, the NRC staff concludes that as a result of FPL's operation of its recovery well system and continued regulatory oversight and enforcement of the terms of the 2016 FDEP Consent Order and 2015 Miami-Dade County DERM Consent Agreement, the impacts on groundwater quality from operations during the subsequent license renewal term would be SMALL. The staff's current impacts projection also considers the fact that the subsequent license renewal term does not commence until 2032 and 2033, for Units 3 and 4, respectively, affording a substantial period of time for ongoing groundwater remediation activities to be effective and improvement in groundwater quality to be accomplished prior to and during the subsequent period of extended operations.

Category 2 Issues

Table 4-2 identifies two Turkey Point site-specific (Category 2) issues related to groundwater resources during the subsequent license renewal term. These issues are analyzed below.

Groundwater Use Conflicts (Plants That Withdraw More Than 100 Gallons per Minute)

For nuclear power plants that withdraw more than 100 gpm (378 L/min) of groundwater to supply a plant's makeup cooling, service water, or potable water needs, there can be conflicts with other local groundwater users if the cone(s) of depression created by a facility's groundwater production extends to offsite well(s). This is a Category 2 issue.

In evaluating the potential impacts resulting from groundwater use conflicts associated with subsequent license renewal, the NRC staff uses as its baseline the existing groundwater resource conditions described in Sections 3.5.2.1 through 3.5.2.3 of this SEIS. These baseline conditions encompass the existing hydrogeologic framework and conditions (including aquifers) potentially affected by continued operations, as well as the nature and magnitude of groundwater withdrawals for cooling and other purposes (as compared to relevant appropriation and permitting standards). The baseline also considers other downgradient or in-aquifer uses and users of groundwater.

As described in Section 3.5.2.3, "Groundwater Use," FPL uses onsite groundwater withdrawn from the Biscayne and Upper Floridan aquifers for a variety of applications in support of Turkey Point Units 3 and 4 operations, as well as for other activities conducted on the Turkey Point site unrelated to Turkey Point Units 3 and 4 operations. Moreover, at the time of initial license renewal as documented in the NRC staff's SEIS for the Turkey Point initial license renewal (NUREG–1437, Supplement 5) (NRC 2002c), no groundwater was being withdrawn for use as makeup water or to support salinity management (i.e., freshening) in the CCS. Since 2014, FPL has substantially increased groundwater usage from both the Biscayne and Upper Floridan aquifers to support freshening of the CCS and, most recently, as part of groundwater extraction activities for remediation of hypersaline groundwater emanating from the CCS.

Conflicts Analysis for the Biscayne Aquifer

In 2018, FPL's groundwater withdrawals from the Biscayne aquifer totaled about 4,630 mgy (17.5 million m^3/yr). This equates to an average withdrawal of 12.7 mgd (48,100 m^3/day) (see Section 3.5.2.3). These withdrawals were associated with the completion of hypersaline groundwater recovery testing using four demonstration wells followed by full-scale operations of the installed hypersaline groundwater recovery well system. FPL did not operate its three marine wells (i.e., wells PW-1, SW-1, and SW-2) during the 2018 reporting period, which also withdraw from the Biscayne aquifer.

FPL commenced full operation of the recovery well system on or about May 15, 2018 (Section 3.5.2.2). The installed system consists of 10 recovery (extraction) wells that FPL has numbered RW-1 through RW-10. These recovery wells are generally located along the western edge of the CCS. The wells are located and designed to extract hypersaline groundwater from near the base of the Biscayne aquifer, and to limit the influence of CCS operations on the regional saltwater interface. Under optimal conditions, the 10-well system has an extraction capacity of 15 mgd (56,700 m^3/day), or 5,475 mgy (20.7 million m^3/yr).

The SFWMD has issued FPL a water use individual permit (Permit No. 13-06251-W) for operation of the recovery well system. The permit specifies a maximum monthly withdrawal allocation of 465 million gal (1.76 million m^3) (SFWMD 2017a). This limit bounds the total installed production capacity of the recovery wells. Additionally, the permit requires that FPL mitigate interference with existing legal uses of groundwater and mitigate harm to natural resources, including effects on surface water or groundwater that result in lateral movement of the saltwater interface or reductions in the hydroperiod of wetlands or natural water bodies, causes the movement of contaminants contrary to water quality standards, or causes harm to the natural system including habitats for rare or endangered species. In such cases, FPL would be required to reduce or otherwise alter groundwater withdrawals to mitigate impacts.

As referenced above, FPL contracted Tetra Tech to develop and perform numerical groundwater modeling to support FPL's water use permit application to SFWMD. The NRC staff reviewed the modeling report (Tetra Tech 2016) as well the SFWMD report and impacts evaluation that were included in FPL's water use individual permit (Permit No. 13-06251-W) (SFWMD 2017a).

The modeling report assessed various operational scenarios for the recovery well system using a regional, three-dimensional, density-dependent, groundwater flow and saltwater transport model to simulate the effects on conditions in the Biscayne aquifer. As described by Tetra Tech (Tetra Tech 2016) and summarized by FPL (2018n), the numerical model features an 11-layer flow system to represent the Biscayne aquifer. The model simulates interactions between the CCS, Biscayne aquifer, Biscayne Bay, and affected surface water canals. Seven recovery well scenarios, reflecting differences in recovery well locations, were modeled for a 10-year simulation period, as compared to a "no-action" scenario. The modeling scenario that Tetra Tech (Tetra Tech 2016) identifies as "alternative 3D" represents the recovery well system that has been constructed by FPL. Modeling results for alternative 3D show that the hypersaline plume within the lower high-flow zone of the aquifer will be retracted back to the eastern edge of the CCS within 10 years and that salinity concentrations are reduced to that of seawater (i.e., 35 PSU) or less in the aquifer beneath the CCS. Predicted offsite drawdowns (i.e., west of the L-31E Canal) are less than 0.2 feet (0.06 m) (Tetra Tech 2016).

The modeling results for the constructed well system predict retraction of the westward plume to the edge of the CCS beginning within about 5 years, and complete retraction within 10 years, with minor aquifer drawdown impacts. In the impacts evaluation report for Permit No. 13-06251-W, SFWMD stated that system operation should, as part of the extraction of hypersaline groundwater, pull the saltwater interface in the Biscayne aquifer seaward (i.e., to the east) from its current location and increase the amount of fresh groundwater in areas surrounding the CCS (SFWMD 2017a).

As also documented in the SFWMD report issued as part of the permit package for Permit No. 13-06251-W and supporting documentation included in SFWMD's online application file (SFWMD 2017a), SFWMD staff reviewed the modeling submitted by FPL (Tetra Tech 2016) and also performed confirmatory analyses. In summary, SFWMD concluded that: (1) recovery well system withdrawals would have no impact on existing legal users of the Biscayne aquifer, (2) predicted drawdowns would not exceed 0.5 feet (0.15 m) with minimal potential to affect water resource availability given the aquifer's total saturated thickness, and (3) withdrawals should result in eastward retraction of the saltwater interface and increase the availability of fresh groundwater in the area of the CCS. SFWMD separately considered a modeling scenario under drought conditions. The drought scenario predicted a maximum drawdown of less than 0.3 feet (0.09 m) in the Biscayne aquifer west and north of the CCS, resulting in minimal potential to impact sawgrass marsh wetlands in the affected areas.

Consistent with the SFWMD report and the modeling results discussed above, FPL's environmental report predicts retraction of the westward plume to the edge of the CCS by about 5 years and complete retraction within 10 years (i.e., by about 2028), with minor aquifer drawdown impacts. Thus, FPL would achieve the compliance deadline for retraction of the hypersaline plume and its effect on the location of the regional saltwater interface, as set forth in its 2016 Consent Order with the FDEP (FDEP 2016a), without undue impact on groundwater resources or producing unintended groundwater use conflicts. In view of the SFWMD and Tetra Tech conclusions, the NRC staff concludes that recovery well operations will likely be successful in achieving their intended results prior to the start of the subsequent license renewal term for Turkey Point (i.e., 2032 for Unit 3 and 2033 for Unit 4). Further, the modeling results and the safeguards imposed by SFWMD through permit conditions provide reasonable assurance that any impacts on groundwater resources and users would be mitigated, while producing beneficial effects on groundwater quality.

The marine wells, used by FPL to pump seawater into the CCS, have a maximum production capacity of about 45 mgd (170,300 m^3/day). FPL has used the marine wells intermittently since they were installed in 2015 to lower salinity in the CCS under abnormal conditions. For instance, while the marine wells were not used in 2016, FPL diverted marine well water into the CCS during a 6-month period in 2017 (FPL 2018m). Marine well water was most recently used in conjunction with water pumped from the newly operational Upper Floridan aquifer freshening wells (i.e., wells F-1, F-3, F-4, F-5, F-6), to manage CCS salinity levels during an exceptionally dry period. This period of very low rainfall began in November 2016 and lasted through the end of the dry season until September 2017 (FPL 2017a, FPL 2017b, FPL 2018m). While operation of the marine wells does not require a water use permit from SFWMD, their operation is subject to FPL's Consent Agreement (MDC 2015a) with Miami-Dade County DERM. The agreement specifies that the marine wells may only be used to lower salinity in the CCS under "extraordinary circumstances." For the period of October 2017 to September 2018, FPL did not need to operate the marine wells due to improved hydrologic conditions and improved CCS salinity, despite a severe dry season in late 2017 and early 2018 (see Section 3.5.1.4, “Adjacent Surface Water Quality and Cooling Canal System Operation” for discussion).

The NRC staff does not expect that periodic use of the marine wells, as might be necessary under abnormal conditions within the CCS, during the period of continued operations extending through the subsequent license renewal term would have any substantial impact on groundwater quality or quantity. The marine wells, located on the Turkey Point peninsula on Biscayne Bay and east of Turkey Point, withdraw saltwater from the upper part of the Biscayne aquifer and would not be expected to impact any wells withdrawing water from the inland portions of the Biscayne aquifer. This is because the permeable Biscayne aquifer in this area is recharged from Biscayne Bay, and any future marine well operation on a temporary basis would be unlikely to substantially alter groundwater flow beyond the affected area or result in any substantial drawdown in the Biscayne aquifer.

Conflicts Analysis for the Upper Floridan Aquifer

In 2018, FPL’s groundwater withdrawals from the Upper Floridan aquifer totaled approximately 7,396 mgy (27.9 million m^3/yr). This equates to an average withdrawal of 20.3 mgd (76,840 m^3/day) (see Section 3.5.2.3). Of the total withdrawn, approximately 12.7 mgd (48,100 m^3/day) was associated with operation of the site’s freshening well system (i.e., wells F-1, F-3, F-4, F-5, F-6) for the CCS, with the remainder (i.e., about 7.6 mgd (28,800 m^3/yr)) associated with the use of the site’s three site production wells (PW-1, PW-3, PW-4).

FPL’s modified site certification and associated conditions of certification for the Turkey Point site authorizes the withdrawal of 14.06 mgd (53,200 m^3/day) of groundwater from the upper production zones of the Upper Floridan aquifer for cooling water for Unit 5 and process water for Units 1, 2, 3, 4, and 5 (i.e., from the site production wells) and an additional 14 mgd (53,000 m^3/day) for CCS salinity reduction (freshening). Thus, FPL’s State-issued site certification authorizes a total average daily withdrawal of 28.06 mgd (106,200 m^3/day) from the Upper Floridan aquifer (State of Florida Siting Board 2016, FDEP 2016b) (Section 3.5.2.3). As stated above, FPL’s groundwater withdrawals from the Upper Floridan aquifer have been less than the authorized amounts.

FPL commissioned the development of a technical evaluation by Tetra Tech (Tetra Tech 2014b) in support of FPL’s proposed use of Upper Floridan aquifer water for CCS freshening as part of the 2014 site certification modification effort (FPL 2018n). The East Coast Floridan Aquifer System Model - Phase 2 (ECFAS2) was used to evaluate potential aquifer drawdown and impacts on other groundwater users from the proposed groundwater use. As Tetra Tech documented in its report (Tetra Tech 2014b), the original ECFAS2 model is a regional, density-dependent groundwater flow and transport model originally developed for the SFWMD to meet SFWMD’s minimum basis of review requirements for water use permitting. The contractor modified and adapted the ECFAS2 model so that the groundwater flow component of the model could be used and calibrated it to current regional conditions (e.g., water levels). Site-specific hydrogeologic conditions were then incorporated into the adapted model by recalibrating the model using two aquifer performance tests performed at Turkey Point. This modified regional model (FPL Floridan model) was used to assess drawdown and potential groundwater use conflicts resulting from the proposed FPL withdrawals at the Turkey Point site and at offsite, regional locations, including potentially affected municipal wellfields (FPL 2018n, Tetra Tech 2014b).

As part of the modeling effort, two sets of simulations were run to assess drawdown in the Upper Floridan aquifer commensurate with SFWMD requirements for water use permitting. The first simulation projected drawdown due to sustained withdrawal at the maximum permitted rate from the freshening system wells alone. The second simulation included the freshening system well production in combination with other existing permitted withdrawals (using permitted rates) in the region. In the simulations, the total production volume was distributed evenly among FPL's wells.

First, SFWMD's basis of review for water use permitting requires that the 1-foot (0.3-m) drawdown contour at permitted wells be determined. Based on this criterion, the modeling results obtained from the FPL Floridan model (Tetra Tech 2014b) show that operation of FPL's freshening system wells at the maximum permitted rate results in four existing aquifer users falling within the 1-foot (0.3-m) drawdown contour attributable to withdrawals from FPL's salinity reduction wells. These locations include the Sound Golf Club, Ocean Reef Club, Florida Keys Aqueduct Authority, Miami-Dade Water and Sewer Department (MDWSD) South Miami Heights wellfield, and FPL Unit 5 well (PW-1).

A maximum drawdown of 15.1 feet (4.6 m) is predicted to occur on the Turkey Point site (i.e., at salinity reduction well F-3). For offsite, non-FPL wells, the model projects a maximum drawdown of 2.26 feet (0.7 m) at the MDWSD's South Miami Heights wellfield, located approximately 10.3 mi (16.6 km) north, northwest of the center point of FPL's freshening well system. However, the incremental drawdown attributable to FPL freshening well system withdrawals constitutes less than 5 percent of the total predicted cumulative drawdown (i.e., drawdown from all permitted withdrawals from the Upper Florida aquifer) at the South Miami Heights wellfield. In contrast, at the Florida Keys Aqueduct Authority located approximately 10 mi (16 km) to the west, the projected incremental drawdown (i.e., 2.16 feet (0.66 m)) is 12 percent of the total cumulative drawdown. The incremental drawdown contribution is also higher for permitted users that are closer to the Turkey Point site. Specifically, the predicted incremental drawdown (2.21 feet (0.67 m)) at Sound Golf Club and Ocean Reef Club (about 9 mi (14 km) south of the FPL freshening wells) is 19 percent of the total cumulative drawdown. Nevertheless, as documented in the modeling report, the predicted incremental drawdowns are conservative or bounding estimates (i.e., the model overestimates the drawdown due to FPL wells at offsite locations than would likely be observed). In all, the modeling analysis performed demonstrates that operation of FPL's salinity reduction wells (freshening well system) is likely to produce measurable, incremental drawdowns in other offsite Upper Floridan aquifer wells.

Further, the modeling results indicate that operation of the FPL freshening well system would be unlikely to result in any changes to regional water quality, as the Upper Floridan aquifer is already brackish, no saltwater interface exists in the confined system, and water quality changes experienced by other aquifer users have been minor (Tetra Tech 2014b). Nonetheless, SFWMD (SFWMD 2012) has documented that wells producing from the Upper Floridan aquifer can experience a degradation in water quality due to vertical seepage (upconing) or lateral movement of more saline water over time.

In accordance with the modified site certification and associated conditions of certification for the Turkey Point site (State of Florida Siting Board 2016, FDEP 2016b), FPL is required to mitigate harm to offsite groundwater users (either related to water quantity or quality) as well as to offsite water bodies, land uses, and other beneficial uses. As necessary, the SFWMD can order FPL to reduce withdrawals or undertake other mitigative actions. FPL is also required to regularly monitor the freshening well system for a number of water quality parameters including

TDS and chlorides and report the results to FDEP and Miami-Dade County on a quarterly basis (FDEP 2016b). Additionally, the 2015 Consent Agreement with Miami-Dade County DERM requires FPL to evaluate alternative water sources for freshening the CCS, including the use of reclaimed wastewater from the County South District Wastewater Treatment Plant, as further described in Section 3.5.2.3 of this SEIS.

Summary of Groundwater Use Conflicts Evaluation

In conclusion, the NRC staff's review indicates that current and projected groundwater withdrawals associated with FPL's operation of its Biscayne aquifer marine well and recovery well systems would be unlikely to have any noticeable, adverse impact on any supply wells beyond the confines of the Turkey Point site. This is because drawdowns in the unconfined Biscayne aquifer are projected to be minor and FPL's withdrawals would induce no adverse changes in the Biscayne aquifer or affect other permitted users of the aquifer. Additionally, modeling projections indicate that FPL's operation of the recovery well system will reduce salinity in the Biscayne aquifer and reduce the westward migration of the regional saltwater interface. Modeling results further indicate that recovery well system operations will be successful in retracting the hypersaline plume to within the boundaries of the Turkey Point property during the current renewed operating license term, although the NRC staff recognizes that uncertainty exists regarding the precise time by which the recovery well system will have achieved its objectives.

FPL's continued operation of its Upper Floridan aquifer production wells, particularly the freshening well system, is likely to affect offsite well systems by increasing drawdown in the aquifer beyond that currently being experienced due to regional groundwater production alone. Currently, available information indicates that FPL will need to operate the five CCS freshening wells (i.e., wells F-1, F-3, F-4, F-5, F-6) in addition to its three site production wells (PW-1, P-3, PW-4) during the subsequent license renewal period of extended operation. The NRC staff finds that the projected drawdowns would noticeably affect the Upper Floridan aquifer, but that FPL's continued withdrawals would not destabilize the groundwater resource or impair the use of the Upper Floridan aquifer by other users and well systems during the period of subsequent license renewal.

Finally, as stated in its environmental report, FPL does not anticipate the need to withdraw groundwater at a rate exceeding its current permits and/or authorizations during the subsequent license renewal period (FPL 2018f). Accordingly, the NRC staff has assumed in this impacts assessment that FPL's groundwater withdrawals from the Upper Floridan aquifer and Biscayne aquifer would not exceed the limits specified in current authorizations and permits. In summary, based on the evaluation presented above, the NRC staff anticipates that operation of the recovery well system will not result in any interference with existing permitted uses of groundwater, will not impact natural resources, and will not result in westward lateral movement of the saltwater interface in the Biscayne aquifer. Further, infrequent operation of FPL's marine wells is not expected to substantially alter groundwater flow or result in any substantial drawdown in the Biscayne aquifer. For the Upper Floridan aquifer, groundwater modeling performed to evaluate aquifer response from continued operation of FPL's freshening well system indicates the potential for appreciable drawdowns in offsite production wells, including in potable water wells located approximately 10 mi (16 km) from the Turkey Point site. While the projected drawdowns would be noticeable in affected offsite wells, the effects would not be expected to affect water availability or impair the Upper Floridan aquifer as a resource. Consistent with these impacts, the NRC staff concludes that the potential for groundwater use conflicts from FPL's groundwater withdrawals would be SMALL for the Biscayne aquifer and MODERATE for the Upper Floridan aquifer during the subsequent license renewal term.

Radionuclides Released to Groundwater

All commercial nuclear power plants routinely release radioactive gaseous and liquid materials into the environment. These radioactive releases are designed to be planned, monitored, documented, and released into the environment at designated discharge points. In contrast, this issue considers the potential impact to groundwater quality from the unplanned, inadvertent discharge of liquids containing radionuclides into groundwater. Such unknown, uncontrolled, and unmonitored releases of radioactive liquids have occurred at nuclear power plant sites from power plant systems, piping, spent fuel pools, valves, and tanks. The majority of the inadvertent liquid release events involved tritium, which is a radioactive isotope of hydrogen. However, other radioactive isotopes, such as cesium and strontium, have also been inadvertently released into the groundwater at some sites. The inadvertent release of radionuclides to groundwater is a Category 2 issue and requires a plant-specific assessment.

In evaluating the potential impacts on groundwater quality associated with license renewal, the NRC staff uses as its baseline the existing groundwater conditions described in Sections 3.5.2.1 through 3.5.2.3 of this SEIS. These baseline conditions encompass the existing quality of groundwater potentially affected by continued operations (as compared to relevant State or EPA primary drinking water standards), as well as the current and potential onsite and offsite uses and users of groundwater for drinking and other purposes. The baseline also considers other downgradient or in-aquifer uses and users of groundwater.

For the Turkey Point site, FPL participates in the Nuclear Energy Institute's NEI 07-07, "Industry Ground Water Protection Initiative" (NEI 2007), which is focused on actions to improve management and response to the inadvertent release of radioactive substances to subsurface soils and water. Since 2010, FPL has maintained a radiological environmental sampling and analysis program for Turkey Point to meet the recommendations of NEI 07-07. FPL performs groundwater monitoring at 28 onsite locations to monitor for potential inadvertent radioactive releases via potential groundwater pathways at the site in accordance with site procedures. Samples are collected on at least a quarterly basis, or more frequently if deemed necessary. FPL reports the results in annual radiological environmental operating reports and submits these to the NRC.

FPL reports that it has experienced a number of inadvertent releases of radionuclides at Turkey Point with the potential to reach groundwater over the last 5 years, which the NRC staff has reviewed and summarized in the subsection titled "Routine and Potential Inadvertent Releases of Radionuclides and Other Pollutants to Groundwater" under Section 3.5.2.2 of this SEIS. Nine such releases were recorded over the period of March 2014 through August 2018. FPL documents such "unplanned" releases in its annual radioactive effluent release reports, which it submits to the NRC. The NRC staff reviewed these reports as part of this environmental review. The releases generally involved water containing tritium as well as other radionuclides including cobalt-58 and sodium-24.

The largest inadvertent release, by liquid volume, involved a sustained release of component cooling water from a leaking heat exchanger, totaling an estimated 4,828 gal (18,280 L). This release occurred during the period from July 26 to September 15, 2015. As discussed in Section 3.5.2.2 of this SEIS, other releases occurred in 2014, 2015, 2017, and 2018, involving substantially smaller releases. In all cases, FPL stopped ongoing releases, surveyed the release area, and increased groundwater sampling in potentially affected areas, as appropriate. FPL documented all such events in the Turkey Point corrective action program, as appropriate.

Table 3-6 in Section 3.5.2.2 of this SEIS summarizes the latest available radiological groundwater monitoring results for Turkey Point and compares the results to historical maximum observed concentrations at each well location. Groundwater monitoring shows that tritium is detectable in underlying groundwater in and around the Turkey Point nuclear island and in areas adjoining the intake and discharge canals. This is not unexpected given the discharge of monitored and permitted effluents containing tritium to the unlined CCS, which is in hydraulic communication with the underlying Biscayne aquifer.

As shown in Table 3-6, in 2018, tritium concentrations in groundwater at Turkey Point Units 3 and 4 ranged from below the minimum detectable concentration to a maximum of 3,390 pCi/L at monitoring well PTN-MW-8S. This maximum tritium level was observed during the fourth quarter of 2018. Monitoring well PTN-MW-8S is located near the Turkey Point Unit 3 refueling water storage tank, between Unit 3 and the cooling water intake canal coming off the CCS (see Figure 3-27). The highest measured tritium concentration in groundwater beneath the Units 3 and 4 plant complex over the last 5 years was 13,600 pCi/L in well PTN-MW-8S during the fourth quarter of 2017. As for plant storm drains, the peak concentration in 2018 was measured in the northeast storm drain at 7,470 pCi/L. This location is on the north side of the intake canal and east of Unit 3 and monitoring well PTN-MW-8S. As referenced in Section 3.5.2.2, measured tritium in storm drains is heavily influenced by the inflow of water from the CCS.

Surficial groundwater (i.e., the Biscayne aquifer) that has been affected by inadvertent releases within the Turkey Point plant property is classified by the FDEP as Class G-III waters, which means it is neither a current nor potential future source of drinking water. There are no discernible trends in the radiological groundwater protection monitoring results that would indicate either a new inadvertent release or an ongoing inadvertent release of radionuclides to groundwater at Turkey Point. Further, the data indicate that there is no occurrence or migration of tritium in groundwater at concentrations exceeding either the tritium limit (30,000 pCi/L) prescribed by the plant Offsite Dose Calculation Manual (FPL 2013a) or the EPA primary drinking water standard (20,000 pCi/L) (40 CFR 141.66, “Maximum Contaminant Levels for Radionuclides”).

Based on the information presented and the NRC staff’s review of groundwater monitoring data, the NRC staff finds that inadvertent releases of radionuclides (primarily tritium) have not substantially impaired site groundwater quality within the Biscayne aquifer and have not affected groundwater use beyond the Turkey Point site. Thus, the NRC staff concludes that groundwater quality impacts from inadvertent releases of radionuclides are SMALL and are projected to remain SMALL during the subsequent license renewal term.

4.5.2 No-Action Alternative

4.5.2.1 Surface Water Resources

Under the no-action alternative, the NRC would not issue subsequent renewed licenses, and Turkey Point would shut down on or before the expiration of the current renewed operating licenses. During shutdown, there would not be any surface water consumption or offsite discharges to surface water bodies and effluent discharges from Units 3 and 4 to the CCS would decrease. Storm water would continue to flow into the CCS. Other facilities at the Turkey Point site would continue to discharge to the CCS, including cooling tower blowdown from Unit 5. Water from the CCS would continue to be circulated through retired fossil fuel Units 1 and 2. However, this circulation would not add heat to the CCS.

After shutdown, the temperature of water within the CCS would be much lower and the rate of evaporation of water from the CCS would decrease. The NRC staff expects that FPL would continue to implement State- and County-required programs to reduce salinities and to control ammonia and nutrients within the CCS, until the desired objectives are achieved. These actions would reduce the potential for waters from the CCS to impact surface water bodies via the groundwater pathway. Therefore, the NRC staff concludes that the impacts to surface water resources from the no-action alternative would be SMALL.

4.5.2.2 Groundwater Resources

Miami-Dade Water and Sewer Department (MDWSD) supplies potable water to Turkey Point for process water makeup, potable uses, and fire protection uses. The source of this water is groundwater pumped from the Biscayne aquifer. With the cessation of operations, FPL's use of potable water at Turkey Point for these uses would be greatly reduced but would not likely cease until sometime during decommissioning. Similarly, FPL's use of groundwater from the Upper Floridan aquifer to supply water for Turkey Point uses would also likely be reduced as a result of shutdown and would eventually cease.

Sanitary wastewater discharges to the Biscayne aquifer via Turkey Point's Class V injection well would also be reduced as the plant workforce is drawn down.

As described in Section 4.5.2.1 of this SEIS, shutdown of Turkey Point would entail a gradual reduction and eventual cessation of condenser cooling water and service water withdrawals from, and return discharges to, the CCS. However, the NRC staff expects that the CCS would continue to receive effluent discharges from Turkey Point Unit 5 for the foreseeable future as well as stormwater runoff from the Turkey Point plant complex and from the balance of the Turkey Point site. Consequently, water in the CCS would continue to be exchanged with groundwater in the underlying Biscayne aquifer.

The shutdown of Turkey Point would substantially reduce thermal discharges to the CCS as well as cooling water and other effluents from the plant's cooling water system. This flow reduction would reduce groundwater mounding (i.e., a localized increase in the water table) beneath the CCS and reduce the generation of hypersaline water. As a result, the NRC staff expects that the amount of water used to support freshening activities in accordance with the provisions of FPL's 2015 Consent Agreement with Miami-Dade County DERM (MDC 2015a) and the 2016 FDEP Consent Order (FDEP 2016a) could be reduced. Currently, the principal source of water for salinity management (i.e., freshening) in the CCS and for reducing the generation of hypersaline groundwater beneath the CCS is derived from five production wells tapping the Upper Floridan aquifer. These withdrawals are described in Section 3.5.2.3 of this SEIS and their impacts are evaluated in Section 4.5.1.2 above. Nevertheless, with the shutdown of Turkey Point Units 3 and 4, the NRC staff expects that some use of water by FPL for salinity management in the CCS would continue indefinitely, possibly at a reduced rate.

The NRC staff also expects that continued operation of the recovery well system and associated deep well injection of the recovered hypersaline water would continue during the shutdown period and at least until the initial remediation objectives of the recovery well system are achieved (i.e., plume attenuation and retraction). As described in detail in Section 4.5.1.2, "Groundwater Resources," modeling results indicate that the recovery well system will be successful in achieving the County and State prescribed remediation objectives during the current operating license term, although uncertainty exists regarding the timing of remediation efforts. Miami-Dade County and the FDEP could as necessary require FPL to develop alternate remediation plans and systems to meet the objectives of the 2015 Consent Agreement (MDC 2015a) and the 2016 FDEP Consent Order (FDEP 2016a). Subsequently, FPL may need to operate and maintain the recovery well and associated deep well injection systems for as long as necessary to achieve and maintain compliance with County and FDEP requirements. Based on the above considerations, the NRC staff concludes that the overall impact of the no-action alternative on groundwater resources would be SMALL.

4.5.3 Replacement Power Alternatives: Common Impacts

4.5.3.1 Surface Water Resources

For all replacement power alternatives considered, the NRC staff assumes that surface water resources would not be consumed and liquid discharges to adjacent surface water bodies would not be allowed during both construction and operation. During construction, all water from dewatering and other activities would be discharged into the CCS. During operations, cooling tower blowdown and radiological liquid discharges would be deep well injected into the Boulder Zone of the Floridan aquifer. Stormwater would be discharged into the CCS.

As discussed in the no-action alternative, under a replacement power alternative, the CCS would no longer be used for cooling by Units 3 and 4 or by any of the replacement power alternatives evaluated. Consequently, the potential for impacts from the CCS on adjacent surface water bodies via the groundwater pathway would be reduced. Therefore, the NRC staff concludes that the common impacts on surface water resources would be SMALL.

4.5.3.2 Groundwater Resources

<u>Construction</u>

Construction activities associated with thermoelectric power facilities at the Turkey Point site would likely require groundwater dewatering, especially of deep excavations associated with emplacement of facility foundations and substructures. This would require the use of cofferdams, sheet pilings, sumps, wells, or other methods to address high water-table conditions. Use of crushed limestone fill at construction sites would reduce the relative depth of excavation work and would minimize post-construction impacts.

Excavation work and dewatering would affect the Biscayne aquifer. As previously evaluated by the NRC staff for the construction of Turkey Point Units 6 and 7, dewatered areas of the aquifer would be quickly recharged locally from surface-water features including the cooling canals, Biscayne Bay, the L-31E Canal, aquifer inflow, and infiltration of rainfall. It is possible that dewatering could induce groundwater flow from the inland portion of the aquifer through deeper permeable layers and toward the dewatering points. However, the volume of inland groundwater captured would be very small (NRC 2016a). Dewatering at the rates (400 to 1,200 gpm (1,500 to 4,500 L/min) projected in Section 4.2.1 of the final EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG–2176) (NRC 2016a) would require a water use permit issued by the SFWMD (FAC 40E-2). The NRC staff expects that any impacts on groundwater flow and quality within the portions of the Biscayne aquifer affected by dewatering would be highly localized and of short duration, with minor effects on other aquifer users.

Once extracted, groundwater would be managed in accordance with FDEP requirements. For example, discharge of extracted groundwater would be governed by conditions specified in an FDEP-issued NPDES general (generic) permit for stormwater discharge from large and small construction activities (FDEP 2018a, FPL 2018f). Dewatering flows could also be discharged to the CCS, which would likely require a modification of FPL's NPDES permit (i.e., industrial wastewater facility permit). A similar scenario was previously evaluated by the NRC staff in Section 4.2.1.4 of the final EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG–2176). There, the NRC staff evaluated a maximum discharge rate to the CCS of 1,200 gpm (450 L/min), equivalent to 1.7 mgd (6,500 m^3/day) over an assumed dewatering period of 1 year. In summary, the NRC staff determined that such a discharge rate would generally not be detectable in the CCS as that rate of discharge would equate to about 0.06 percent of the recirculating flow rate of the CCS. The NRC staff further concluded that the impacts on groundwater quality, including from additional seepage from the CCS, would be minor (NRC 2016a).

Construction of replacement power generating facilities at the Turkey Point site would increase the amount of impervious surface as well as alter the subsurface strata because of excavation work and the placement of backfill following facility completion. While an increase in impervious surface would reduce infiltration and reduce groundwater recharge, the effects on water-table elevations in the underlying Biscayne aquifer would likely be very small given the relatively small surface area affected and the high permeability of the aquifer. Below-grade portions of new power generating facilities at the site could alter the direction of groundwater flow. Such effects would likely be localized, and the NRC staff does not expect them to affect offsite groundwater users or adjacent surface water bodies, including Biscayne Bay.

Application of best management practices in accordance with a stormwater pollution prevention plan developed for the FDEP-issued NPDES generic permit, including appropriate waste management, water discharge, and spill prevention practices, would prevent or minimize any areawide groundwater quality impacts during construction.

The construction of additional onsite underground injection wells and associated monitoring wells may be necessary to support the disposal of effluent streams from operations. Such wells could also be used to dispose of any wastewaters generated during facility construction. In association with the construction of Turkey Point Units 6 and 7, the NRC staff evaluated the construction of 10 underground injection wells, 2 backup wells, and 6 dual-zone monitoring wells. The wells would be more than 3,000-feet (914-m) deep and completed in the Boulder Zone of the Lower Floridan aquifer. Construction of these wells would be subject to FDEP Class I industrial waste underground injection control permits (FAC 62-528). In Section 4.2.3 of the final EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG-2176), the NRC staff determined that activities related to the construction of injection wells and monitoring wells in the Boulder Zone would have negligible effects on groundwater quality in the surficial Biscayne aquifer and the deeper Floridan aquifer system (NRC 2016a).

Water would be required for such uses as dust control and soil compaction, as well as to meet the drinking and sanitary needs of the construction workforce during the construction period for all facilities. The use of portable sanitary facilities, serviced by a commercial vendor, would serve to reduce water use and sanitary wastewater generation by the construction workforce. Consistent with the assumptions in FPL's environmental report submitted as part of this subsequent license renewal application and as previously considered in the final EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG-2176) (NRC 2016a), the NRC staff assumes that water would be obtained from the Miami-Dade Water and Sewer Department

(MDWSD). The principal water source for the MDWSD is the Biscayne aquifer. The NRC staff projects that maximum water use to support construction would be approximately 0.8 mgd (3,000 m^3/day). The volume of water required would be a very small percentage of the capacity of the County system (NRC 2016a).

Operation

Post-construction groundwater dewatering may be required during the operational period of the onsite power generating facilities. Dewatering rates would be much lower than those projected for the construction period. Operational dewatering would be subject to water use permitting requirements administered by the SFWMD (FAC 40E-2). Once extracted, groundwater would be managed in accordance with FDEP requirements, including applicable NPDES permitting requirements.

Onsite thermoelectric power generating facilities would use mechanical draft cooling towers for condenser cooling. For the purposes of analysis and as referenced in Section 2.2 of this SEIS, the NRC staff assumes that these cooling towers would be similar to those previously described in Section 3.4.2.2 of the final EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG-2176) (NRC 2016a). The source of makeup water would be reclaimed wastewater supplied by the MDWSD (see Table 2-1). The NRC staff assumes that no groundwater would be directly used to support operation of replacement power generating facilities.

Replacement power facilities would also require freshwater for general service water, fire protection, demineralized water makeup, and potable and sanitary use. The NRC staff assumes that this water would be obtained from MDWSD via an existing right-of-way and/or a proposed new supply pipeline to the Turkey Point site as described in Section 3.2.3 of the final EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG-2176) (NRC 2016a).

The onsite thermoelectric power generating facilities would produce cooling tower blowdown, treated radiological wastewater, sanitary wastewater, and other effluent streams. Consistent with the assumptions in the final EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG-2176) (NRC 2016a), the NRC staff assumes that these effluent streams would be disposed of via underground injection wells to the Boulder Zone. Disposal would occur via the same or similar wells as proposed for use in support of Unit 6 and 7 operations. Any new wells would be constructed and operated in accordance with underground injection control permits issued by the FDEP (FAC R62-528).

In Sections 3.4.2, 5.2.1.3, 5.2.3, and 5.8 of the final EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG-2176) (NRC 2016a), the NRC staff evaluated the deep well injection of up 90 mgd (341,000 m^3/day) of cooling water blowdown and other liquid waste streams from proposed Units 6 and 7. The NRC staff concluded in part that proper well design and isolation of the Boulder Zone by low-permeability strata would prevent degradation of overlying underground sources of drinking water. The Boulder Zone deep injection wells would be permitted by FDEP. This permit would require FPL to implement institutional controls and monitoring programs to detect upward migration of injected wastewater. As a result, the NRC staff concluded that operational groundwater-quality impacts would be SMALL (NRC 2016a).

It is expected that stormwater runoff from onsite thermoelectric power generating facilities would be conveyed to the CCS. Use of the CCS would require that FPL modify its NPDES permit (i.e., industrial wastewater facility permit) for operation of the facility. Since the CCS is in hydraulic communication with the underlying Biscayne aquifer, any pollutants in stormwater runoff could reach groundwater. Nevertheless, as facility operations would be subject to pollution prevention and best management practices required by FDEP, the NRC staff considers potential water quality impacts on groundwater quality to be minimal.

As described in Section 4.5.2.2 for the no-action alternative, the NRC staff expects that groundwater demands for CCS freshening would decrease over time for the replacement power alternatives, commensurate with a reduction in thermal discharge to the CCS, but that some use of water by FPL for salinity management in the CCS would continue indefinitely. The NRC staff expects that the volume of water needed for CCS freshening will be governed by the provisions of FPL's 2015 Consent Agreement with Miami-Dade County DERM (MDC 2015a) and the 2016 FDEP Consent Order (FDEP 2016a), recognizing that those requirements are subject to possible modification in the future. In addition, continued operation of the recovery well system, and associated deep well injection of the recovered hypersaline water, may be necessary for some period of time to maintain compliance with the above-referenced State and County regulatory agreements. System operations would remain subject to applicable permit, monitoring, and reporting requirements imposed by State agencies, as previously discussed in Section 4.5.1.2 (see "Conflicts Analysis for the Biscayne Aquifer").

4.5.4 New Nuclear Alternative

4.5.4.1 Surface Water Resources

The NRC staff did not identify any impacts to surface water resources for this alternative beyond those discussed above as common to all replacement power alternatives. Therefore, the NRC staff concludes that the impacts to surface water resources from this alternative would be SMALL.

4.5.4.2 Groundwater Resources

Groundwater use and quality impacts from construction and operations associated with the new nuclear alternative would likely be similar to but somewhat less than those described and assumed as common to all alternatives in Section 4.5.3.2. This is due to the reduced construction footprint and operational impacts. The staff projects that the use of reclaimed wastewater for cooling tower makeup and the generation of cooling tower blowdown and other effluents would be reduced by about 30 percent, as compared to the proposed Turkey Point Units 6 and 7. This would produce cooling tower blowdown along with other effluents at a rate of approximately 9 mgd (34,100 m^3/day). These wastewaters would be disposed of by deep well injection into the Boulder Zone beneath the Turkey Point site (see Section 4.5.3.2). Therefore, the NRC staff concludes that the impacts on groundwater resources from construction and operations associated with the new nuclear alternative would be SMALL.

4.5.5 Natural Gas Combined-Cycle Alternative

4.5.5.1 Surface Water Resources

The NRC staff did not identify any impacts to surface water resources for this alternative beyond those discussed above as common to all replacement power alternatives. Therefore, the NRC staff concludes that the impacts to surface water resources from the natural gas combined-cycle alternative would be SMALL.

4.5.5.2 Groundwater Resources

Groundwater use and quality impacts from construction activities and operations associated with the natural gas combined-cycle alternative would be much smaller than those described in Section 4.5.3.2. This is because less extensive excavation work and associated dewatering would be required for construction. As for operations, the NRC staff projects that cooling water demand associated with operation of cooling towers and the generation of blowdown and other effluent streams would be reduced by approximately 80 and 70 percent, as compared to the proposed Turkey Point Units 6 and 7 and new nuclear alternative, respectively, given the comparatively lower level of cooling needed for the natural gas plant. This would produce cooling tower blowdown along with other effluents at a rate of approximately 2.4 mgd (9,100 m^3/day), which would be disposed of by deep well injection into the Boulder Zone (see Section 4.5.3.2).

Construction of a new natural gas pipeline would result in additional ground-disturbing impacts and the need for dewatering areas around pipeline pad and pier supports. However, any groundwater impacts would likely be localized and temporary.

For this alternative, the NRC staff concludes that the impacts on groundwater resources from construction and operations would be SMALL.

4.5.6 Combination Alternative (Natural Gas Combined-Cycle and Solar Photovoltaic Generation)

4.5.6.1 Surface Water Resources

The NRC staff did not identify any impacts to surface water resources for this alternative, beyond those discussed above as common to all replacement power alternatives. Therefore, the NRC staff concludes that the impacts to surface water resources from this alternative would be SMALL.

4.5.6.2 Groundwater Resources

Groundwater use and quality impacts from construction activities and operations associated with the onsite natural gas combined-cycle component of this alternative would be very similar to those referenced in Section 4.5.5.2. This is because the construction and operational aspects of the natural gas combined-cycle power plant would be similar.

The NRC staff expects that there would be little or no groundwater use or groundwater quality impacts for construction and operations of the onsite and offsite solar facilities. This is because groundwater dewatering would likely be minimal due to the relatively small footprint of pad sites, access roads, and utility corridors where excavation, grading, and trenching might be required.

Based on the above, the NRC staff concludes that the overall impacts on groundwater resources from construction and operations associated with the combination alternative would be SMALL.

4.5.7 Cooling Water System Alternative

4.5.7.1 Surface Water Resources

The NRC staff did not identify any impacts to surface water resources for this alternative beyond those discussed above as common to all replacement power alternatives. Therefore, the NRC staff concludes that the impacts to surface water resources from this alternative would be SMALL.

4.5.7.2 Groundwater Resources

No onsite groundwater would be required to support cooling tower construction. Water would be required for such uses as dust control, soil compaction, as well as to meet the drinking and sanitary needs of the construction workforce during the construction period for all facilities. Consistent with the assumptions in the final EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG-2176) (NRC 2016a), the NRC staff assumes that water for such uses would be obtained from the MDWSD, which primarily uses the Biscayne aquifer as a water source. The NRC staff expects that construction water would be trucked to the point of use as needed from onsite service connections with MDWSD. Onsite water demands to support cooling tower construction could be reduced by the use of ready-mix concrete and the use of portable sanitary facilities for construction workers that are serviced offsite.

Groundwater dewatering would likely be required in excavations associated with below-grade portions of the cooling towers. Construction activities would include the use of cofferdams, sheet pilings, sumps, wells, or other methods to address high water-table conditions as they exist at the Turkey Point site. Depending on the rate and duration of dewatering activities, dewatering activities would have to be permitted under a SFWMD-issued water use permit or, more likely, under a general permit-by-rule for temporary dewatering (FAC 40E-2). The NRC staff expects that any impacts on groundwater flow and quality within the portions of the Biscayne aquifer affected by dewatering would be highly localized and of short duration, with minor effects on other aquifer users.

Once extracted, the NRC staff assumes that groundwater would be properly managed in accordance with FDEP requirements. Specifically, an FDEP-issued NPDES general permit for stormwater discharge from large and small construction activities would govern the discharge of extracted groundwater and all ground-disturbing activities. The construction contractor would be required to implement best management practices and other controls (including appropriate waste management, water discharge, and spill prevention practices) under a stormwater pollution prevention plan (FDEP 2018a). These would serve to mitigate any impacts on groundwater quality during construction.

During commissioning of the cooling water system alternative, Turkey Point may be offline for a period of time. Groundwater production on the Turkey Point site associated with the operation of the five CCS freshening wells (F-1, F-3, F-4, F-5, F-6) withdrawing from the Upper Floridan aquifer and the three site production wells (PW-1, PW-3, PW-4) would be expected to continue at current rates during the transition period.

As described in Section 4.5.2.2 for the no-action alternative, the NRC staff expects that the CCS would continue to operate under this alternative and would receive cooling tower blowdown and other effluents and runoff from Turkey Point Unit 5 as well as stormwater from the Turkey Point plant complex and other FPL facilities. While the NRC staff expects that groundwater demands for CCS freshening would decrease over time commensurate with the reduction in thermal discharge to the CCS from Turkey Point Units 3 and 4, some use of groundwater (or other water sources) would likely continue indefinitely. The NRC staff expects that the volume of water needed for CCS freshening will be governed by the provisions of FPL's 2015 Consent Agreement with Miami-Dade County DERM (MDC 2015a) and the 2016 FDEP Consent Order (FDEP 2016a), recognizing that those requirements are subject to possible modification in the future. Further, as also described in Section 4.5.2.2, continued operation of the recovery well system and associated deep well injection of the recovered hypersaline water may be necessary for some period of time to maintain compliance with the above-referenced State and County regulatory requirements. System operations would remain subject to applicable permit, monitoring, and reporting requirements imposed by State and County agencies, as previously discussed in Section 4.5.1.2.

No onsite groundwater or MDWSD-supplied groundwater would be used during operation of the Turkey Point cooling water system alternative, as the cooling towers would be supplied by treated, reclaimed wastewater. Otherwise, onsite use of MDWSD-supplied groundwater from the Biscayne aquifer for Turkey Point Units 3 and 4 potable water and fire protection use (see Section 3.5.2.3, "Groundwater Use") would be similar to the volumes used during the current renewed license period.

Operation of the mechanical-draft cooling towers for condenser cooling would produce cooling tower blowdown at a projected rate of 11 mgd (41,600 m^3/day). This effluent stream would contain cooling water treatment and conditioning chemical residuals (e.g., biocides, corrosion inhibitors) necessary for proper operation and maintenance of the cooling towers and Turkey Point Units 3 and 4 circulating water system. Additionally, Turkey Point Units 3 and 4 operations would continue to produce various process water effluents, including liquid radwaste effluents. The NRC staff assumes that these effluents would be disposed of by deep well injection into the Boulder Zone, which would be regulated under a Class I underground injection control permit issued by the FDEP (FAC 62-528).

As referenced in Section 4.5.3.2, the NRC staff previously evaluated the deep well injection of up 90 mgd (341,000 m^3/day) of cooling water blowdown and other liquid waste streams from proposed Turkey Point Units 6 and 7. The NRC staff concluded in part that proper well design and isolation of the Boulder Zone by low-permeability strata would prevent degradation of overlying underground sources of drinking water. The Boulder Zone deep injection wells would be permitted by FDEP, and FPL would be required to implement institutional controls and monitoring programs to detect upward migration of injected wastewater. As a result, the NRC staff concluded that operational groundwater-quality impacts would be SMALL (NRC 2016a). The NRC staff finds that the disposal of effluents by deep well injection of effluents under this alternative would be bounded by the cited analysis.

In consideration of the information and assumptions presented above, the NRC staff concludes that the impacts on groundwater resources from construction and operation of the cooling water system alternative would be SMALL.

4.6 Terrestrial Resources

This section describes the potential terrestrial resources impacts of the proposed action (subsequent license renewal) and alternatives to the proposed action.

4.6.1 Proposed Action

As identified in Table 4-1, "Applicable Category 1 (Generic) Issues for Turkey Point," in Section 4.1 of this chapter, the impacts of all generic terrestrial resource issues would be SMALL. According to the GEIS (NRC 1996 and 2013a), terrestrial resources would not be significantly affected by continued operations associated with license renewal. For the terrestrial resource issues addressed in the 2013 GEIS, no new and significant information was identified that would alter the GEIS conclusions for Category 1 issues for Turkey Point subsequent license renewal. New information related to one of these categories, "Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds)," is discussed below. Also, in Section 4.1 of this chapter, Table 4-2, "Applicable Category 2 (Site-Specific) Issues for Turkey Point," identifies one site-specific (Category 2) issue related to terrestrial resources during the subsequent license renewal term. That issue is also analyzed below.

<u>New Information, Category 1 Issue, Cooling System Impacts on Terrestrial Resources (Plants with Once-Through Cooling Systems or Cooling Ponds)</u>

As referenced in Section 1.4 of this SEIS and as further described under Sections 1.5 and 1.8 of the GEIS (NUREG-1437) (NRC 2013a), no additional site-specific analysis is required by the NRC staff for Category 1 (generic) issues in the SEIS unless new and significant information is identified that would change the conclusions in the GEIS. Where new and significant information has been identified, the NRC staff would reconsider generic impacts in the SEIS.

The Category 1 issue, "Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds)," was first evaluated in the 1996 GEIS (NRC 1996) under the name, "Cooling pond impacts on terrestrial resources." This issue was modified and renamed in Revision 1 to the GEIS, which was issued in June 2013 (NRC 2013a).

For the subject issue, the 2013 GEIS (NRC 2013a: 4-64 - 4-69) considers potential impacts to terrestrial resources from contaminants and physical alterations of the environment resulting from cooling system operations. As a part of the analysis, the 2013 GEIS describes several site-specific examples of plants with cooling ponds and the NRC staff's conclusions regarding the effects on terrestrial resources as documented in site-specific SEISs, including the potential effects from the CCS at Turkey Point. The 2013 GEIS (NRC 2013a: page 4-68) specifically states the following:

> Groundwater quality can be degraded by contaminants present in cooling ponds and cooling canals. Deep-rooted terrestrial plants could be exposed to these contaminants. In addition, biota could be exposed to contaminants at locations of groundwater discharge, such as wetlands or riparian areas. However, as noted above, contaminant concentrations are typically very low, and any effects on terrestrial plants would be expected to be SMALL. Mitigation may also be implemented where sensitive resources could be affected. At the Turkey Point plant in Florida, for example, the flow of hypersaline groundwater from the cooling canals toward the Everglades to the west is prevented by an interceptor ditch, located along the west side of the canal system, from which groundwater inflow is extracted (NRC 2002b).

Since publication of the 2013 GEIS, new information has indicated that the interceptor ditch has not prevented the movement of hypersaline groundwater in the deep Biscayne aquifer west of the Canal L-31E Levee. Section 3.6 of this SEIS presents and considers relevant new information related to terrestrial resources at the Turkey Point site concerning the subject issue.

Specifically, Section 3.6.2, "Marsh, Mangrove, and Tree Island Semiannual Monitoring," of this SEIS summarizes results from FPL's ecological monitoring through 2018. This monitoring is a requirement of the FDEP's Conditions of Certification in connection with the Turkey Point extended power uprate and the SFWMD's Fifth Supplemental Agreement. With respect to marshes and mangroves near the Turkey Point site, monitoring data support the conclusion that the CCS does not have a discernable ecological impact on the surrounding areas and that there is no clear evidence of CCS water in the surrounding marsh and mangrove areas from a groundwater pathway (FPL 2018o). Although FPL has observed some ecological changes, these changes have been seasonally and meteorologically driven. For instance, one freshwater marsh plot experienced a complete die-off of sawgrass in connection with Hurricane Irma, which made landfall in Southern Florida in September 2017. The same plot began exhibiting recovery during subsequent sampling events. Mangroves have exhibited an overall stable structure and composition. Porewater samples have indicated no evidence of impacts from the CCS on soil porewater quality via the groundwater pathway. Current data suggest that operation of the CCS does not have a noticeable impact on wetlands or any other important attribute of the terrestrial environment on or near the Turkey Point site. It also suggests that the interceptor ditch has prevented the westward movement of near surface groundwater and attendant impacts on local ecology. In conclusion, the NRC staff has determined that the new information available since the publication of the 2013 GEIS is not significant because it does not change the finding of SMALL for the Category 1 issue of "Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds)."

4.6.1.1 Category 2 Issue Related to Terrestrial Resources: Effects on Terrestrial Resources (Non-Cooling System Impacts)

According to the GEIS (NUREG-1437), non-cooling system impacts on terrestrial resources can include those impacts that result from landscape maintenance activities, stormwater management, elevated noise levels, and other ongoing operations and maintenance activities that would occur during the subsequent license renewal period on or near a plant site.

Landscape Maintenance and Operational Activities

FPL's (FPL 2018f; FPL 2018g) landscape maintenance and operational activities during the subsequent license renewal term would remain similar to those currently conducted. These activities primarily consist of mowing, string trimming, hedge trimming, weed removal, herbicide application, tree trimming, brush removal, debris removal, and the maintenance and repair of plant infrastructure such as roadways, piping installations, fencing, and security-related structures. FPL does not anticipate performing refurbishment during the subsequent license renewal period (FPL 2018f).

Within developed portions of the site—such as near the power block, administrative buildings, and transmission lines and associated infrastructure—landscape activities generally include vegetative trimming and mowing, herbicide application, and infrastructure maintenance and repair. Herbicide treatment would primarily occur in areas connecting the collector yard to the switch yard. FPL (2018f) applies commercially approved herbicides in accordance with its Florida site certification application and applicable Federal and State regulations. For example, FPL must notify the FDEP Southeast District of the Department of Siting Coordination Office at least 60 days prior to the first use of an herbicide. Herbicide treatment, vegetative trimming and mowing, and infrastructure maintenance in these areas could disturb or displace wildlife and birds. However, most wildlife near these areas are likely relatively tolerant of human activity given the current level of operational activities onsite. Any wildlife that become disturbed or displaced when landscape activities occur would be able to find similar habitat onsite or nearby. In addition, the displacement period would be limited to a few hours or days.

Within less-developed portions of the site that contain high-quality terrestrial habitats—such as freshwater wetlands, mangroves, or wooded areas—ground-disturbing maintenance activities include hand and mechanical vegetative control, hand and mechanical debris removal, maintenance of the CCS access roads (e.g., mechanical scrapping and aggregate placement), underground piping repair (e.g., digging and equipment staging), and equipment replacement at groundwater wells and monitoring stations. FPL annually removes exotic species, such as Australian pine (*Casuarina equisetifolia*) and Brazilian pepper (*Schinus terebinthifolius*), from within CCS canals and berms and along the access and CCS perimeter roads. FPL removes such species using an amphibious excavator backhoe and a D-3 Dozer, piling the vegetation on the CCS berms and then burning the vegetation in accordance with the FPL burn permit issued by the Florida Department of Agriculture and Consumer Services (FDACS) Permit 1373498 (FPL 2018g). Removal occurs along berms that provide habitat for federally protected species (American crocodile (*Crocodylus acutus*)), State-protected species (least terns (*Sterna antillarum*)), and other wildlife and birds. Within areas that FPL has defined as crocodile sanctuaries, FPL maintains all native species after removing exotic species. On all other berms, FPL uses power equipment to maintain a low level of small brush, grass, and weeds. Although removal and burning could disturb wildlife and result in increased sedimentation within the CCS, such impacts are likely minimized given that the burning activities occur in accordance with the FDACS permit, and that work in or around active American crocodile nests sites is prohibited from March to August. These and other potential impacts on the American crocodile are addressed in Section 4.8.1.1, "Federally Listed Species and Critical Habitats Protected Under the Endangered Species Act," of this SEIS, and in the NRC staff's Biological Assessment (NRC 2018n). Wildlife and birds would likely be displaced during such activities. However, displacement would be limited to the short duration of the activity and similar habitat would be accessible both on and within the vicinity of the site. In addition, the removal of the exotic species promotes the growth of native and rare species.

Environmental impacts from landscape maintenance and operational activities would also be minimized because FPL maintains environmental control procedures for any activities that result in the clearing of land, excavation, or other activity that would alter the physical environment or ecology of the site (FPL 2018f and FPL 2018g). FPL's procedures direct personnel to obtain appropriate local, State, or Federal permits (or some combination of the three) before beginning work; implement best management practices to protect wetlands, natural heritage areas, and sensitive ecosystems (see the paragraph below, "Stormwater Management"); and consult the appropriate agencies wherever federally or State-listed species may be affected. Turkey Point's Environmental Protection Plan contained in Appendix B of the current renewed operating licenses requires FPL to prepare an environmental evaluation for any construction or operational activities which may significantly affect the environment (NRC 2002a). If such an evaluation indicates that an activity involves an unreviewed environmental question, the Turkey Point Environmental Protection Plan requires that FPL obtain approval from the NRC before performing the activity (NRC 2002d). The subsequent renewed licenses, if issued, would include an environmental protection plan with identical or similar requirements.

Stormwater Management

Stormwater runoff from impervious surfaces can change the frequency or duration of inundation and soil infiltration within wetlands, mangroves, and neighboring terrestrial habitats. Effects of stormwater runoff may include erosion, altered hydrology, sedimentation, and other changes to plant community characteristics. Runoff may contain sediments, contaminants and oils from road or parking surfaces, or herbicides. At Turkey Point, stormwater collected in drainage channels and floor drains is discharged directly to the CCS. Turkey Point does not discharge stormwater directly into Biscayne Bay or any other surface waters other than the CCS. Use of the stormwater conveyance system, which collects stormwater, minimizes the amount of excess runoff that terrestrial habitats would receive and the associated effects. FDEP regulations require a stormwater permit and Stormwater Pollution Prevention Plan for any construction activities or activities that would result in the clearing of land, excavation, or other action that would alter the physical environment or ecology of the site. FPL's Stormwater Pollution Prevention Plan identifies potential sources of pollutants that could affect stormwater discharges and identifies best management practices that FPL uses to reduce pollutants in stormwater discharges to ensure compliance with applicable conditions of the permit (FPL 2018g). The best management practices include soil stabilization, such as seeding and structural controls (e.g., silt fences). FPL has also developed a Spill Prevention, Control, and Countermeasures Plan that identifies and describes the procedures, materials, equipment, and facilities that are utilized to minimize the frequency and severity of oil spills (FPL 2018f). Collectively, these measures ensure that the effects to terrestrial resources from pollutants carried by stormwater would be minimized during the proposed subsequent license renewal term.

Noise

The GEIS (NUREG-1437) (NRC 2013a) states that elevated noise levels from transformers and other equipment could disrupt wildlife behavioral patterns or cause animals to avoid such areas. However, limited wildlife occurs in areas of the Turkey Point site with elevated noise levels due to the developed nature of those portions of the site, associated lack of high-quality habitat, and regular presence of human activity. Wildlife that does occur in developed areas is likely tolerant of disturbance due to decades of operations. Therefore, noise associated with the continued operation of transformers and other plant equipment during the proposed subsequent license renewal term is unlikely to create noticeable impacts on terrestrial resources.

Conclusion

Based on the NRC staff's independent review, the staff concludes that the landscape maintenance activities, stormwater management, elevated noise levels, and other ongoing operations and maintenance activities that FPL might undertake during the subsequent license renewal term would primarily be confined to already-disturbed areas of the Turkey Point site. Within less-developed portions of the site, disturbances to wildlife would be minimal, and wildlife could use similar habitat nearby during the limited periods of the disturbance. Therefore, these activities would neither have noticeable effects on terrestrial resources nor would they destabilize any important attribute of the terrestrial resources on or in the vicinity of the Turkey Point site. Accordingly, the NRC staff concludes that non-cooling system impacts on terrestrial resources during the subsequent license renewal term would be SMALL.

4.6.2 No-Action Alternative

Under the no-action alternative, the NRC would not issue subsequent renewed licenses, and Turkey Point would shut down on or before the expiration of the current renewed licenses. Some impacts on terrestrial resources would cease following reactor shutdown while other impacts may continue to exist at a reduced level. For example, noise impacts and impacts associated with herbicide application and landscape maintenance could continue for some time following reactor shutdown depending on the level at which FPL continues to maintain landscaped areas. Other impacts on terrestrial resources would be the same as if the plant were still operating, such as the potential for bird collisions with plant structures and transmission lines.

The CCS would continue to operate under the no-action alternative regardless of the proposed Turkey Point subsequent license renewal because it supports retired fossil fuel Units 1 and 2. FPL plans to continue to use water from the CCS to support the operation of these units in synchronous condenser mode over the course of the proposed subsequent license renewal period, as described in Section 3.1.3, "Cooling and Auxiliary Water Systems." Additionally, fossil fuel Unit 5 would remain in operation and would continue to discharge blowdown to the CCS. CCS conditions could change under the no-action alternative because less heat would be discharged to the system. This would potentially reduce evaporation resulting in less saline conditions that would be more favorable for birds and wildlife. On the other hand, CCS flow would likely decrease because Turkey Point Units 3 and 4 would withdraw substantially reduced quantities of water during the shutdown period, and eventually Turkey Point Units 3 and 4 would cease to circulate water through the CCS entirely. This could lead to stagnant conditions, which could be less favorable for birds and wildlife and promote algae growth. Regardless, FPL would continue CCS restoration activities, as previously described in Section 4.5.2.2 of this SEIS. The State of Florida requires these activities under FPL's Nutrient Management Plan, which is independent of subsequent license renewal. The CCS would likely continue to provide wildlife habitat for foraging and breeding, and restoration activities would benefit wildlife that rely upon the CCS as a source of prey. Thus, shutdown itself is unlikely to noticeably alter or have more than minor effects on terrestrial resources.

The NRC staff concludes that the impacts of the no-action alternative on terrestrial resources during the proposed subsequent license renewal term would be SMALL.

4.6.3 Replacement Power Alternatives: Common Impacts

Each replacement power alternative would entail construction and operation of a new energy generating facility on FPL's existing Turkey Point site or the surrounding area and would result in qualitatively similar impacts to terrestrial resources. During construction of a replacement power facility, the use of the Turkey Point site would allow FPL to maximize existing buildings and infrastructure. However, due to the prevalence of important terrestrial habitats onsite—such as freshwater wetlands, mangroves, and wooded habitats—it is unlikely that FPL would be able to avoid impacting sensitive and important terrestrial habitats. Impacts from construction could result in both the permanent and temporary loss of important terrestrial habitats, habitat fragmentation, and habitat degradation from runoff, erosion, and sedimentation, depending on the specific areas used for construction. Wildlife and birds would likely avoid the area during the construction of a replacement power facility due to noise and other disturbances. Limiting construction in areas near known bird nests, rookeries, or colonies (e.g., CCS berms on which least terns are known to nest) to the non-breeding season would limit behavioral avoidance and other potential impacts to locally breeding bird populations. Collisions with tall structures and vehicles could also result in wildlife and bird mortality. Implementation of appropriate best management practices, revegetation following construction, and required compensatory mitigation for unavoidable wetland impacts would minimize such impacts.

In the GEIS (NUREG-1437) (NRC 2013a), the NRC staff concluded that for all nuclear power plants, impacts to terrestrial resources from operation of nuclear and fossil-fueled plants would be similar and would include cooling tower salt drift, noise, bird collisions with plant structures and transmission lines, as well as impacts connected with herbicide application and landscape management. Additional impacts to terrestrial resources during the operational period could occur as a result of offsite mining, extraction, or waste disposal activities associated with each plant's particular type of fuel.

As described above under the no-action alternative, the CCS would continue to operate regardless of the proposed Turkey Point license renewal because it supports retired fossil fuel Units 1 and 2. FPL plans to continue to withdraw water from the CCS to support these units' operation in synchronous condenser mode over the course of the proposed subsequent license renewal period, as described in Section 3.1.3, "Cooling and Auxiliary Water Systems." Additionally, Unit 5, which remains in operation, discharges blowdown to the CCS. CCS conditions could change with implementation of one of the replacement power alternatives because less heat would be discharged to the system. This would potentially reduce evaporation resulting in less saline conditions that would be more favorable for birds and wildlife. On the other hand, CCS flow would likely decrease because Turkey Point Units 3 and 4 would withdraw substantially reduced quantities of water during the shutdown period, and eventually all withdrawals associated with these units would cease. Less flow could lead to stagnant conditions, which could be less favorable for birds and wildlife and enhance algae growth. Regardless, FPL would continue CCS restoration activities, as previously described in Section 4.5.3.2. The State of Florida requires these activities under FPL's Nutrient Management Plan, which is independent of subsequent license renewal. The CCS would likely continue to provide wildlife habitat for foraging and breeding, and restoration activities would benefit wildlife that rely upon the CCS as a source of prey.

4.6.4 New Nuclear Alternative

The NRC staff did not identify any impacts on terrestrial resources for the new nuclear alternative beyond those discussed in the impacts common to all replacement power alternatives. However, the common impact onsite could be slightly more intense for the new nuclear alternative as compared to the natural gas alternative. This can be attributed to the larger land area required for the new nuclear power block, which could result in increased erosion and potential introduction of sediments to wetland habitats. In addition, given the prevalence of wetlands within the Turkey Point site, it is unlikely that FPL would be able to avoid permanently filling or disturbing wetlands when siting the new nuclear alternative. Given that the construction of the new nuclear alternative would result in the permanent disturbance, fragmentation, and degradation of up to 360 ac (150 ha) of important terrestrial habitats, the NRC staff concludes that the impacts to terrestrial resources from construction and operation of a new nuclear alternative would be MODERATE.

4.6.5 Natural Gas Combined-Cycle Alternative

The onsite impacts on terrestrial resources would be less intense for construction of a natural gas plant as compared to a new nuclear plant because the natural gas plant would disturb less land. However, the natural gas alternative would also require construction of a 1,200-ac

(490-ha) long right-of-way for a gas pipeline, which could result in the loss, modification, and fragmentation of important terrestrial habitats. Collocation of the right-of-way with other existing rights-of-way would minimize the amount of habitat disturbance. The natural gas alternative would also emit pollutants that could degrade wetland and other important habitats. As described above, the CCS would continue to operate regardless of whether a replacement power alternative is implemented, and the impacts discussed previously that would be associated with continued operation of the CCS would apply to this alternative. The NRC staff concludes that the impacts of constructing and operating the natural gas alternative on terrestrial resources would be MODERATE due to the permanent disturbance, fragmentation, and degradation of important terrestrial habitats.

4.6.6 Combination Alternative (Natural Gas Combined-Cycle and Solar Photovoltaic Generation)

The NRC staff did not identify any impacts to terrestrial resources for the natural gas portion of the combination alternative beyond those described for the natural gas-only alternative. For the solar portion of the combination alternative, the exact level of disturbance to terrestrial habitats and biota would depend on the amount of land required for each unit and the specific siting of buildings and infrastructure within the site footprint. Due to the prevalence of important terrestrial habitats within the areas where the solar units would be sited, it is likely that construction would result in the temporary and permanent disturbance, fragmentation, and degradation of important terrestrial habitats. Utility-scale solar facilities may also pose hazards to birds and their insect prey if individual birds or insects mistake a facility's reflective panel arrays for water. Birds and insects may be injured or killed from collision with solar panels if they try to land on or enter what they interpret to be water in what has been termed by researchers as the "lake effect hypothesis" (Kagan e al. 2014). The U.S. Fish and Wildlife Service (FWS) is currently developing mitigation strategies and best management practices related to birds and solar facilities (MASCWG 2016). Discussions with the FWS and other relevant agencies during the planning phases of the solar portion of the combination alternative could minimize impacts to birds and other wildlife by incorporating mitigation and best management practices into the design of the facility and construction plans. As described above, the CCS would continue to operate regardless of whether a replacement power alternative is implemented, and the impacts discussed previously that would be associated with continued operation of the CCS would apply to this alternative. The NRC staff concludes that the impacts of implementing the combination alternative on terrestrial resources would be MODERATE during construction and operation due to the impact on important terrestrial habitat.

4.6.7 Cooling Water System Alternative

The NRC staff did not identify any impacts on terrestrial resources for the cooling water system alternative beyond those discussed in the impacts common to all replacement power alternatives. In addition, the common impacts would be less intense for the cooling water system alternative due to the smaller land area required for construction and operation. Nonetheless, construction would likely result in the temporary or permanent disturbance, fragmentation, and degradation of important terrestrial habitats. As described above, the CCS would continue to operate regardless of whether cooling towers are constructed to support Turkey Point Units 3 and 4, and the impacts discussed previously that would be associated with continued operation of the CCS would apply to this alternative. The NRC staff concludes that the impacts to terrestrial resources from construction and operation of a cooling water system alternative would be MODERATE due to the noticeable impacts from the permanent disturbance, fragmentation, and degradation of important terrestrial habitats.

4.7 Aquatic Resources

This section describes the potential aquatic resources impacts of the proposed action (subsequent license renewal) and alternatives to the proposed action.

4.7.1 Proposed Action

As identified in Table 4-1, "Applicable Category 1 (Generic) Issues for Turkey Point," in Section 4.1 of this chapter, the impacts of all generic aquatic resource issues would be SMALL. The NRC staff analyzed Category 1 issues in the GEIS (NRC 2013a) and determined that the impacts of continued nuclear power plant operation during a license renewal term would have SMALL effects for these issues. The NRC staff has identified no new or significant information for aquatic resource Category 1 issues that would call into question the GEIS's conclusions for subsequent license renewal of Turkey Point Units 3 and 4. Accordingly, and as concluded in the GEIS, the impacts of the Category 1 aquatic resource issues identified in Table 4-1 would be SMALL for the proposed Turkey Point subsequent license renewal. Table 4-2, "Applicable Category 2 (Site-Specific) Issues for the Turkey Point Site," in Section 4.1 of this SEIS identifies two aquatic resources site-specific (Category 2) issues applicable to Turkey Point during the subsequent license renewal term. These issues are analyzed below.

4.7.1.1 Impingement and Entrainment of Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds)

For plants with once-through cooling systems or cooling ponds such as Turkey Point, the NRC (2013a) has determined that impingement and entrainment of aquatic organisms is a Category 2 issue that requires site-specific evaluation. In 2002, the NRC staff evaluated the impacts of the Turkey Point initial license renewal on aquatic organisms as two issues: "impingement of fish and shellfish" and "entrainment of fish and shellfish in early life stages." For both issues, the NRC staff determined that impacts would be SMALL. In 2013, the NRC issued Revision 1 of the GEIS (NUREG-1437) (NRC 2013a), which combined these two issues into a single site-specific issue—"Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)." This section evaluates this consolidated issue as it applies to the proposed Turkey Point subsequent license renewal period.

Impingement is the entrapment of all life stages of fish and shellfish on the outer part of an intake structure or against a screening device during periods of water withdrawal (40 CFR 125.83, "What Special Definitions Apply to This Subpart?"). Impingement can kill organisms immediately or contribute to later mortality resulting from exhaustion, suffocation, injury, and other physical stresses. The potential for injury or death is generally related to the amount of time an organism is impinged, its susceptibility to injury, and the physical characteristics of the screen-washing system and fish return (if present) of the plant.

Entrainment is the incorporation of all life stages of fish and shellfish with intake water flow entering and passing through a cooling water intake structure and into a cooling water system (40 CFR 125.83). Organisms susceptible to entrainment are generally of smaller size than those susceptible to impingement and include ichthyoplankton (fish eggs and larvae), larval stages of shellfish and other macroinvertebrates, zooplankton, and phytoplankton. Entrained organisms may experience physical trauma and stress, pressure changes, excess heat, and exposure to chemicals, any of which may result in injury or death (Mayhew et al. 2000).

A particular species can be subject to both impingement and entrainment if several life stages occur near a plant's intake. For instance, adults may be impinged against the screens, while larvae and eggs may be entrained. Depending on the size of the intake screen openings, juveniles can be susceptible to both impingement and entrainment: larger juveniles may be impinged, while smaller juveniles may be entrained. The magnitude of impacts on the aquatic environment resulting from impingement and entrainment depends on plant-specific characteristics of the cooling system (e.g., location of the plant intake, intake velocities, withdrawal volumes, screen technologies, and presence or absence of a fish return system) as well as characteristics of the aquatic resources (e.g., species present in the region, population distributions, species status, management objectives, and life history characteristics).

Below, the NRC staff analyzes impingement and entrainment during the proposed Turkey Point subsequent license renewal term in two parts. First, the staff considers impacts that would be experienced by the aquatic biota in the CCS, and second, the staff considers biota in adjacent natural aquatic environments, including Biscayne Bay and Card Sound.

<u>Aquatic Organisms of the CCS</u>

Aquatic organisms inhabiting the CCS may be impinged or entrained when water is drawn from the CCS into the Turkey Point intake structure. Water from the CCS flows from the canal system into eight intake channels and through 9.5-mm (0.37-inch) mesh intake screens at a rate of 4.48 feet per second (fps) (1.4 meters per second (m/s)). The maximum flow per intake channel is 225,375 gpm (14.2 m^3/s). Debris, including fish and other aquatic organisms, that become impinged on the screens are washed off and disposed of by FPL personnel. The Turkey Point intake structure does not contain a fish return system (FPL 2018g).

FPL has not conducted any impingement or entrainment studies within the CCS. The Federal Water Pollution Control Act (i.e., the Clean Water Act of 1972, as amended (CWA)) (33 U.S.C. 1251 et seq.) does not impose ecological study requirements because the State classifies the CCS as an industrial wastewater facility and because the CCS does not directly withdraw from or discharge into any natural surface waters. Due to the lack of impingement and entrainment data, the NRC staff evaluates the effects of this potential effect on CCS aquatic organisms qualitatively in this section. First, the NRC staff considers the baseline condition of the resource (i.e., the species that would be present and susceptible to impingement and entrainment during the proposed subsequent license renewal). The staff then considers whether the life history characteristics of these species combined with the engineering parameters of the Turkey Point intake structure would make impingement or entrainment likely. The staff then makes an overall conclusion for impingement and entrainment on aquatic organisms of the CCS.

Baseline Condition of the Resource

Section 3.7.3, "Aquatic Resources on the Turkey Point Site," of this SEIS describes the aquatic resources on the Turkey Point site and summarizes the results of past ecological surveys of the CCS. In this section, the NRC staff discusses the facts that several fish species reported from the CCS in 2007 and 2009 ecological surveys were not collected in the most recent 2016 ecological survey, submerged aquatic vegetation is no longer present in the system, and species diversity has generally declined over time. The surface water quality factors that have contributed to this ecological shift are described in Section 3.5.1, "Surface Water Resources."

No direct surface water connections between the CCS and any natural waterbodies exist that would allow additional species to enter the CCS during the proposed subsequent license renewal term. Thus, the NRC staff assumes that the baseline condition of the resource is the aquatic community as it occurs in the CCS today. The current community is of low diversity and includes only those species that can withstand hot, hypersaline waters with low dissolved oxygen and poor water clarity. In 2016, Ecological Associates, Inc. (EAI 2017) collected only the following four species from the CCS:

- sheepshead minnow (Cyprinodon variegatus)
- sailfin molly (Poecilia latipinna)
- eastern mosquitofish (Gambusia holbrooki)
- mudflat fiddler crabs (Uca rapax)

Although other species may continue to occur in the CCS in small numbers that were not captured during the 2016 study, the NRC staff considers the species listed above to be representative of the current CCS aquatic community. For the purposes of this analysis, the staff assumes that these species are also representative of the aquatic community that would be present in the CCS and susceptible to impingement and entrainment during the proposed subsequent license renewal term of 2032 through 2052 (Unit 3) and 2033 through 2053 (Unit 4). Below, the staff considers the vulnerability of these species to impingement or entrainment to determine the overall impact of impingement and entrainment on CCS aquatic organisms.

Impingement

To assess the risk of impingement on CCS organisms, the NRC staff compared documented swim speeds of representative CCS species to the water velocity at the Turkey Point intake structure. In scientific literature, fish swimming speeds are characterized as burst, prolonged, or sustained. Burst speeds are the highest speeds a fish can attain over very short periods of time (typically less than 20 seconds). Burst speeds are exhibited when an individual is capturing prey, avoiding a predator, or negotiating high water velocities, such as those associated with riffles and eddies in a fast-flowing river or the draw of a power plant's intake. Sustained speeds are low speeds fish can maintain indefinitely without fatigue. These speeds are observed during routine activities, including foraging, holding, and schooling. Prolonged (or critical) speeds are those of intermediate endurance that a fish could endure for approximately 20 to 30 minutes before ending in fatigue. If a species' reported swimming ability indicates that individuals can typically swim faster than a power plant's intake velocity, the species would exhibit a low likelihood of being impinged. Certain species may not be capable of maintaining a sustained speed that would allow escape from an intake velocity, but an individual could swim in a burst to avoid impingement. Swim speeds are typically measured in centimeters per second (cm/s). Thus, the NRC staff assumes that species with a documented burst speed less than 140 cm/s (1.4 m/s; 4.48 fps), which is the velocity of the Turkey Point intake, would be susceptible to impingement, and a species with a documented burst speed equal to or greater than this velocity would generally not be susceptible to impingement.

Sheepshead minnow belong to the family Cyprinodontidae. In laboratory tests, Leavy and Bonner (Leavy and Bonner 2009) determined the burst swimming speed of two species in this family of fish, plains killifish (*Fundulus zebrinus*) and blackstripe topminnow (*F. notatus*), to be 30.7 to 43.4 cm/s (0.307 to 0.434 m/s; 1.01 to 1.42 fps). Species-specific data is not available for sheepshead minnow. Therefore, for comparison, the NRC staff assumes that this range is comparable to the burst swim speed of sheepshead minnow. Based on this assumption, sheepshead minnow are susceptible to impingement at Turkey Point and any individuals within the area influenced by the Turkey Point intake velocity are likely to become impinged.

Sailfin molly and eastern mosquitofish both belong to the family Poeciliidae. In laboratory tests, Leavy and Bonner (Leavy and Bonner 2009) determined the burst swimming speed of two Poeciliidae species—sailfin molly and largespring gambusia (*Gambusia geiseri*)—to be 15.7 to 18.6 cm/s (0.157 to 0.186 m/s; 0.52 to 0.61 fps). In another test, Srean et al. (Srean et al. 2016) determined the critical swim speed of adult eastern mosquitofish to be 14.11 cm/s (0.1411 m/s; 0.46 fps). Based on this information, both sailfin molly and eastern mosquitofish are susceptible to impingement at Turkey Point.

Juvenile and adult mudflat fiddler crabs inhabit the intertidal zones of muddy areas of salt marshes and mangroves. Therefore, they would not generally occur in the open water of the CCS where they would be susceptible to impingement. Thus, mudflat fiddler crabs are likely not impinged or only rarely impinged by the Turkey Point intake structure.

Based on the available biometric information presented above, the NRC staff assumes that all fish in the CCS are susceptible to impingement. Because the Turkey Point intake structure does not have a fish return system, and FPL has no plans to alter the design or function of the Turkey Point cooling system under the proposed action, all impingement would result in mortality. However, most fish in the CCS are not at risk of impingement due to the layout of the system and the large size of the CCS relative to the small area influenced by the Turkey Point intake structure's withdrawal of water. Only those individuals in the CCS intake canal, specifically, would be at risk of impingement and only those individuals within the smaller area influenced by the intake velocity are likely to be impinged. Many fish in the CCS likely spend their lives in the main canals and are never exposed to impingement risk. In contrast, for a power plant whose intake draws from a river, migration or movement of fish past the plant would likely necessitate passage through the zone of the power plant intake's influence. For the reasons discussed above, the NRC staff concludes that while impingement at Turkey Point is likely to affect CCS aquatic populations, only a small portion of aquatic organisms would be susceptible to impingement at any given time.

Entrainment

A species' susceptibility to entrainment is closely related to the life history characteristics of early life stages. Species that lay adhesive eggs that sink to the bottom of the water column are less likely to be entrained than species that lay demersal eggs that float within the water column. Sheepshead minnow eggs are adhesive; these eggs stick to plants and bottom substrate and are, therefore unlikely to be entrained. Sailfin molly and eastern mosquitofish give birth to live young rather than laying a clutch of eggs. Newly born young of these species are, therefore, at risk of entrainment if young occur in the CCS intake canal and within the area influenced by the Turkey Point intake structure. Female mudflat fiddler crabs release eggs into the water column where they hatch into microscopic free-swimming larvae that then go through several molt stages. During this process, zoea would be susceptible to entrainment if they occur in water drawn into the Turkey Point intake structure. As with impingement, the NRC staff assumes that even for those species and life stages for which entrainment is possible, only a small portion of susceptible individuals occur in the CCS intake canal and, thus, entrainment risk is relatively low.

Impingement and Entrainment Conclusion for Cooling Canal System Aquatic Organisms

All fish inhabiting the CCS are likely susceptible to impingement, and early life stages of some species are also susceptible to entrainment. The large size of the CCS relative to the small area influenced by intake velocity of the Turkey Point intake structure mitigates the overall risk of impingement and entrainment. In the absence of specific studies, the extent to which impingement or entrainment may result in detectable or noticeable effects on the aquatic populations of the CCS is unknown. However, impingement and entrainment are unlikely to create effects great enough to destabilize important attributes of the aquatic environment over the course of the proposed subsequent license renewal term because the CCS aquatic community is composed of common species that exhibit no unique ecological value or niche and have no commercial or recreational value. The NRC staff, therefore, finds that impingement and entrainment during the proposed subsequent license renewal term would be of SMALL to MODERATE significance on the aquatic organisms of the CCS.

Aquatic Organisms of Biscayne Bay

Aquatic organisms inhabiting Biscayne Bay are not subject to impingement or entrainment because there are no surface water connections that allow flow between the waters of the Biscayne Bay and the CCS. Thus, aquatic organisms in Biscayne Bay and connected waterbodies (e.g., Card Sound, the Atlantic Ocean) never interact with the Turkey Point intake structure. Accordingly, the NRC staff concludes that the issue of impingement and entrainment during the proposed subsequent license renewal term does not apply to aquatic organisms in Biscayne Bay.

4.7.1.2 Thermal Impacts on Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds)

For plants with once-through cooling systems or cooling ponds such as Turkey Point, the NRC staff (NRC 2013a) has determined that thermal impacts on aquatic organisms is a Category 2 issue that requires site-specific evaluation. In 2002, the NRC staff evaluated the impacts of the Turkey Point initial license renewal on aquatic organisms as "heat shock," and the NRC determined that impacts would be SMALL. In 2013, the NRC issued Revision 1 of the GEIS (NUREG-1437) (NRC 2013a), which renamed this issue as "Thermal impacts on aquatic organisms (plants with once-through cooling systems or cooling ponds)." This section evaluates this issue for the proposed Turkey Point subsequent license renewal period.

The primary form of thermal impacts that would be of concern at Turkey Point is heat shock, which the NRC staff (NRC 2013a) defines as occurring when the water temperature meets or exceeds the thermal tolerance of a species for some duration of exposure. In most situations, fish are capable of moving out of an area that exceeds their thermal tolerance limits, although some aquatic species lack such mobility. Heat shock is typically observable only for fish, particularly those species that float when dead.

Aquatic Organisms of the CCS

Heated water discharged from Turkey Point moves from the discharge canal on the north end of the CCS, through 32 feeder canals, and south into a single collector canal that distributes water to 7 return canals. Water in the return canals flows north to the Turkey Point intakes. Excess heat is naturally dissipated through evaporation and groundwater exchange as water flows through the system. Thus, fish and other aquatic organisms experience the highest temperatures at the north end of the CCS within the discharge canal with gradually decreasing temperatures as water flows south through the system.

FPL has not conducted any thermal impact studies within the CCS. The Clean Water Act does not impose ecological study requirements on the CCS because the State of Florida classifies the CCS as an industrial wastewater facility and also because the CCS does not directly withdraw from or discharge into any natural surface waters. In the absence of thermal studies, the NRC staff evaluates the potential effects of thermal discharges on CCS aquatic organisms by comparing CCS discharge temperature data with the thermal tolerances of the species present in the CCS.

Baseline Condition of the Resource

As explained in the NRC staff's impingement and entrainment analysis in Section 4.7.1.1 of this SEIS, the staff assumes that the baseline condition of the resource for the proposed action is the aquatic community as it occurs in the CCS today. The current community is of low diversity and includes only those species that can withstand hot, hypersaline waters with low dissolved oxygen and poor water clarity. Only four species—sheepshead minnow, sailfin molly, eastern mosquitofish, and mudflat fiddler crab—were collected during the last ecological survey of the CCS in 2016 (EAI 2017). For the purposes of this analysis, the staff assumes that these species are also representative of the aquatic community that would be present in the CCS and susceptible to thermal stress during the proposed subsequent license renewal term.

Prior to the 2016 survey, a number of fish, mollusks, crabs, and submerged aquatic vegetation were observed or recorded as occurring in the CCS (described in Section 3.7.3, "Aquatic Resources on the Turkey Point Site," of this SEIS). These species have either been eliminated from the CCS or persist in such low numbers that they were not collected during the 2016 survey. Submerged aquatic vegetation was determined to be completely absent from the system at the time of the 2016 survey, and EAI (EAI 2017) stated in its report that temperature-related stress was one of the factors that contributed to the die-off of the CCS's seagrass beds. The NRC staff acknowledges EAI's conclusion regarding seagrass and recognizes that thermal discharges associated with Turkey Point have contributed not only to the disappearance of seagrass within the CCS, but also to the decline of fish and other aquatic biota and the observed shift towards more heat-tolerant species in recent years. The staff addresses these impacts in the cumulative impact analysis in Section 4.16.4, "Aquatic Resources," because they are past impacts associated with the current renewed license term. The analysis below focuses on future impacts that would be associated with the proposed subsequent license renewal term of 2032 through 2052 (Unit 3) and 2033 through 2053 (Unit 4).

Cooling Canal System Discharge Temperature Data

For each calendar month, FPL reports the highest average daily temperature of the cooling water discharge at Outfall 001 to the FDEP as a requirement of the Turkey Point industrial wastewater facility NPDES Permit No. FL0001562 (FDEP 2005). Table 4-3 below presents these daily maximum temperatures for the past 5 full calendar years (2012–2017). As is typical for the region, the highest temperatures occur in July, and the lowest temperatures occur in January. However, CCS discharge temperatures remain relatively high year-round and are often above the thermal tolerances of many fish (often around 95 °F (35 °C)). FPL (2018g) reports that water temperatures drop approximately 13.7 °F (7.6 °C) over the course of flow from the discharge point to the south end of the CCS. Thus, the minimum temperature likely ranged from roughly 69.9 to 97.9 °F (21.1 to 36.6 °C) with some thermal stratification occurring such that deeper areas of the canal system would have experienced slightly lower temperatures than those measured at the surface.

Table 4-3 Average Maximum Daily Temperature at CCS Outfall 001

	Temperature (°F) [(a)]					
Month	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
January	97.3	90.6	89.9	89.1	95.7	91.0
February	94.7	68.8	106.5	100.3	94.1	98.6
March	94.7	83.6	101.1	105.0	103.2	95.4
April	91.2	93.6	106.7	109.0	90.1	94.8
May	97.1	97.6	103.2	102.7	104.6	103.4
June	90.0	109.2	107.9	112.2	109.7	104.6
July	100.2	111.6	108.2	107.2	111.5	108.3
August	89.8	106.6	106.6	110.4	110.4	110.0
September	97.6	108.4	100.2	105.2	110.4	101.9
October	97.5	101.5	99.0	94.0	94.8	101.9
November	95.0	94.2	89.0	102.6	96.3	96.8
December	93.1	94.8	103.2	94.7	100.4	97.5

[(a)] To convert temperatures in degrees Fahrenheit to Celsius, subtract 32 and multiply by 5/9.

Source: FPL 2018g

Thermal Tolerances of Aquatic Species

Sheepshead minnow are part of the family Cyprinodontidae, which are known for their ability to survive extreme seasonal and diurnal shifts in water temperature. Sheepshead minnow, specifically, can be found in the harsh environments of subtropical south Texas's shallow tide pools at temperatures as high as 109.4 °F (43 °C) and when the combination of other abiotic conditions become so extreme that no other species can persist (Strawn and Dunn 1967; Harrington and Harrington 1961). In static and dynamic thermal tolerance tests of 800 sheepshead minnow collected from a shallow tidepool of the Brazos Santiago Pass in Texas, Bennet and Beitinger (Bennett and Beitinger 1997) found that the species has the largest physiological thermal tolerance range ever measured in a fish. In the tests, individuals acclimated to 69.8 °F (21.0 °C) and 100.4 °F (38.0 °C) were able to tolerate temperatures up to 104.18 °F (40.1 °C) and 111.56 °F (44.2 °C), respectively. Bennet and Beitinger (Bennett and Beitinger 1997) determined the species' critical thermal maxima—the temperature at which activity becomes disorganized and an organism loses its ability to escape conditions which will promptly lead to death—to be 113 °F (45.1 °C).

Both the sailfin molly and eastern mosquitofish are also rather heat-tolerant species. In critical thermal maxima tests, these species have been found capable of withstanding temperatures up to or slightly higher than 104 °F (40 °C) (Fischer and Schlupp 2009; Meffe et al. 1995). Mudflat fiddler crabs have been documented as tolerating waters of temperatures up to 111.4 °F (44 °C) (Smithsonian 2009). The mobility of this species also allows individuals to leave waters that are too hot and seek refuge elsewhere.

Thermal Impacts Discussion

The aquatic community of the CCS is composed of species that can survive in extreme temperatures. CCS temperature data indicate that water in the system remains below the thermal tolerances of the aquatic species present during the majority of the year. During the summer months, waters at and near the cooling water discharge at CCS Outfall 001 may approach or exceed the thermal tolerances of aquatic species. However, the CCS is a large system, and the area over which water temperatures would be uninhabitable would be relatively small. Thus, fish and other mobile aquatic organisms could seek refuge in cooler areas. Additionally, the State has required FPL to implement a thermal efficiency plan (described in detail in Section 3.5.1) as a condition of the 2016 Consent Order to control CCS salinity and temperature (FDEP 2016a). FPL has begun implementing this plan, and FPL's continued execution of the plan will ensure that CCS temperatures are moderated over the course of the proposed subsequent license renewal term. The combination of these factors (i.e., the heat-tolerant aquatic community present in the CCS, the small area of the CCS over which water temperatures typically exceed species' critical thermal maxima, and the State-mandated requirements for FPL to control CCS temperatures and salinity) make the likelihood of mortality of aquatic organisms from Turkey Point's thermal effluent during the subsequent license renewal term relatively low. Nevertheless, the high-temperature environment of the CCS is likely to exert physiological stress on aquatic organisms that could have fitness consequences, including reproductive effects, increased susceptibility to disease or infection, and reduced ability to escape predators. While these effects may be noticeable, they are unlikely to destabilize important attributes of the aquatic environment over the course of the proposed subsequent license renewal term.

Thermal Impact Conclusion for CCS Aquatic Organisms

The aquatic community that currently inhabits the CCS can withstand high temperatures and continued thermal discharges from Turkey Point over the course of the proposed subsequent license renewal period are unlikely to further alter the composition of the community. Thermal impacts may result in some degree of physiological stress on CCS aquatic organisms. In the absence of specific studies, the extent to which such stresses may result in detectable or noticeable effects is unknown. However, thermal impacts are unlikely to create effects great enough to destabilize important attributes of the aquatic environment over the course of the proposed subsequent license renewal term because the CCS aquatic community is composed of species that exhibit no unique ecological value or niche and have no commercial or recreational value. The NRC staff, therefore, finds that thermal impacts during the proposed subsequent license renewal term would be of SMALL to MODERATE significance on the aquatic organisms of the CCS.

<u>Aquatic Organisms of Biscayne Bay</u>

Aquatic organisms inhabiting Biscayne Bay are not subject to thermal impacts associated with Turkey Point because there are no surface water connections that allow flow between these waters and the CCS. Thus, aquatic organisms in this water body and connected waterbodies (e.g., Card Sound, the Atlantic Ocean, etc.) do not interact with Turkey Point's thermal discharge. Accordingly, the NRC staff concludes that the issue of thermal impacts during the proposed subsequent license renewal term does not apply to aquatic organisms in Biscayne Bay.

4.7.2 No-Action Alternative

Under the no-action alternative, the NRC would not issue subsequent renewed licenses, and Turkey Point Units 3 and 4 would shut down on or before the expiration of the current renewed licenses. The CCS would continue to operate to support retired fossil fuel Units 1 and 2 in synchronous condenser mode. If Turkey Point Units 3 and 4 were to cease operating, impacts to CCS aquatic resources would decrease or stop following reactor shutdown. The amount of CCS water withdrawn for cooling purposes would decrease significantly following shutdown, although some withdrawal would continue during the shutdown period as the remaining fuel cools. The reduced demand for cooling water would substantially decrease the effects of impingement, entrainment, thermal effluents, and other impacts to aquatic biota in the CCS. Withdrawals would eventually cease, which would eliminate these impacts.

The CCS would continue to operate under the no-action alternative regardless of the proposed Turkey Point subsequent license renewal because it supports retired fossil fuel Units 1 and 2. FPL plans to continue to use water from the CCS to support the operation of these units in synchronous condenser mode over the course of the proposed subsequent license renewal period, as described in Section 3.1.3, "Cooling and Auxiliary Water Systems." Additionally, fossil fuel Unit 5 would remain in operation and would continue to discharge blowdown to the CCS. CCS conditions could change under the no-action alternative because less heat would be discharged to the system. This would potentially reduce evaporation resulting in less saline conditions that would be more favorable to aquatic life. On the other hand, CCS flow would likely decrease because Turkey Point Units 3 and 4 would withdraw substantially reduced quantities of water during the shutdown period, and eventually Turkey Point Units 3 and 4 would cease to circulate water through the CCS entirely. This could lead to stagnant conditions and lower habitat quality. Stagnant conditions could potentially promote algae growth. Regardless, the CCS would continue to provide habitat for the existing aquatic community. Additionally, FPL would continue CCS restoration activities, as previously described in Section 3.5.1.4, "Adjacent Surface Water Quality and Cooling Canal System Operation," and Section 3.7, "Aquatic Resources," of this SEIS. The State of Florida requires these activities under FPL's Nutrient Management Plan, which is independent of subsequent license renewal. Restoration activities would likely eventually return portions of the CCS to a seagrass-based ecological system. These restoration activities would benefit fish and shellfish inhabiting the CCS as well as other wildlife that rely upon the CCS as a source of prey.

The no-action alternative would not affect aquatic resources in Biscayne Bay, Card Sound, or the Atlantic Ocean because there are no surface water connections that allow flow between these waters and the waters of the CCS; therefore, aquatic organisms in these waterbodies do not interact with the Turkey Point intake structure and are not subject to impingement, entrainment, thermal discharges, or any other effects.

The NRC staff concludes that the impacts of the no-action alternative on aquatic resources would be SMALL.

4.7.3 Replacement Power Alternatives: Common Impacts

Each replacement power alternative would entail construction and operation of a new energy generating facility on the existing 9,500-ac (3,800-ha) Turkey Point site but outside the footprint of Turkey Point Units 3 and 4 and outside the footprint of the proposed Turkey Point Units 6 and 7. Each replacement plant would use mechanical draft cooling towers that would draw water from reclaimed wastewater at varying rates depending on each alternative's cooling requirements. Both alternatives involving a new natural gas plant would require a pipeline to connect the new facility to an existing natural gas supply line located approximately 100 mi (160 km) north of the Turkey Point site.

For all alternatives discussed in this section, the impacts of construction on aquatic resources would be qualitatively similar. During construction, the use of the existing Turkey Point site would allow FPL to use some existing buildings and infrastructure. However, an additional 75 to 540 ac (30 to 220 ha) of undeveloped land on or near the site would be required depending on the specific alternative. The solar component of the combination alternative may require up to 1,400 ac (570 ha) of additional offsite land, and rights-of-way and gas extraction may require additional land, as well. Given the prevalence of wetlands, mangrove forests, mudflats, and other aquatic features on and near the Turkey Point site, it is unlikely that FPL would be able to completely avoid destroying or degrading these habitats during construction of buildings, cooling towers, and other plant components associated with any of the replacement power alternatives. Thus, construction would likely result in permanent loss of some onsite aquatic habitats. The resulting habitat fragmentation could affect ecosystem function and connectivity of aquatic habitats. Habitat degradation associated with runoff, erosion, and sedimentation during construction could also occur. Additionally, direct mortality of aquatic organisms could result from dredging, wetland and mangrove filling, and other necessary in-water work. Barge traffic associated with delivery of construction supplies and plant components to the site would release pollutants into aquatic habitats and could result in collision-related injury or mortality of larger aquatic organisms, especially turtles and marine mammals.

Appropriate permits would mitigate some water quality and aquatic resource impacts by requiring FPL to implement best management practices or other mitigation measures during construction and/or operation. The U.S. Army Corps of Engineers (USACE) or the FDEP would oversee applicable Clean Water Act permitting, including Section 404 permits for dredging and fill activities, Section 401 certification, and Section 402(p) National Pollutant Discharge Elimination System (NPDES) general stormwater permitting. While adherence to these permits would minimize effects on aquatic resources, the prevalence of sensitive aquatic habitats on the Turkey Point site would make some level of impact unavoidable. Construction of any of the replacement power alternatives could affect wetland or mangrove connectivity and could degrade or reduce the value of these habitats as nurseries for fish and shellfish. Such effects would likely be noticeable and could destabilize these attributes of the aquatic environment depending on the particular alternative selected and the siting of the plant.

During operation of any of the replacement power alternatives, the potential impacts on aquatic resources would be qualitatively similar to those that would be experienced as a result of the proposed action of subsequent license renewal. Once built, operation of a replacement power plant would have minimal to no discernable impacts on aquatic resources given that a new power plant would use reclaimed wastewater for cooling. Thus, impingement, entrainment, thermal effects, and water use conflicts would not be an issue.

As described above under the no-action alternative, the CCS would continue to operate regardless of the proposed Turkey Point subsequent license renewal because it supports retired fossil fuel Units 1 and 2. FPL plans to continue to use water from the CCS to support the operation of these units in synchronous condenser mode over the course of the proposed subsequent license renewal period, as described in Section 3.1.3, "Cooling and Auxiliary Water Systems." Additionally, fossil fuel Unit 5 would remain in operation and would continue to discharge blowdown to the CCS. CCS conditions could change with implementation of one of the replacement power alternatives because less heat would be discharged to the system. This would potentially reduce evaporation resulting in less saline conditions that would be more favorable to aquatic life. On the other hand, CCS flow would likely decrease because Turkey Point Units 3 and 4 would withdraw substantially reduced quantities of water during the shutdown period, and eventually Turkey Point Units 3 and 4 would cease to circulate water through the CCS entirely. This could lead to stagnant conditions and lower habitat quality. Stagnant conditions could potentially promote algae growth. Regardless, the CCS would continue to provide habitat for the existing aquatic community. Additionally, FPL would continue CCS restoration activities, as described in Section 3.5.1.4, “Adjacent Surface Water Quality and Cooling Canal System Operation,” and Section 3.7, “Aquatic Resources,” of this SEIS. The State of Florida requires these activities under FPL’s Nutrient Management Plan, which is independent of subsequent license renewal. Restoration activities would likely eventually return portions of the CCS to a seagrass-based ecological system. These restoration activities would benefit fish and shellfish inhabiting the CCS as well as other wildlife that rely upon the CCS as a source of prey.

4.7.4 New Nuclear Alternative

The NRC staff did not identify any impacts to aquatic resources for the new nuclear alternative beyond those discussed in the impacts common to all replacement power alternatives. As described above, the CCS would continue to operate regardless of whether a replacement power alternative is implemented, and the impacts discussed previously that would be associated with continued operation of the CCS would apply to this alternative. However, the common impact would be more intense for the new nuclear alternative compared to the other alternatives because of the larger land area requirement, which would result in more habitat loss and the potential for higher rates of erosion and sedimentation into aquatic habitats. Impacts of this alternative would be MODERATE to LARGE in the local environs of the plant due to the sensitive nature of the wetlands, mangrove forests, mudflats, and other nearby aquatic habitats and the likelihood that construction would convert (destroy) or degrade these habitats. The permanent loss or alteration of these aquatic habitats would likely result in habitat fragmentation that could affect ecosystem function and connectivity of aquatic habitats. The exact level of impact would depend on whether the chosen site results in the permanent loss, impairment, fragmentation, or reduced ecosystem function of affected aquatic habitats.

4.7.5 Natural Gas Combined-Cycle Alternative

The common impacts described above would be less intense for the natural gas alternative compared to the new nuclear alternative. Because the natural gas alternative would disturb less land, it would, therefore, have less likelihood of impairing aquatic habitat connectivity or function. In addition to the common impacts, the natural gas alternative would require construction of a gas pipeline, which could result in erosion, sedimentation, or disturbance of aquatic habitats during the construction phase. The exact degree of impacts would depend on the amount and quality of aquatic habitat along the chosen pipeline route and the implementation of best management practices during construction. During operation, the natural gas alternative would emit pollutants that could degrade aquatic habitats. As described above, the CCS would continue to operate regardless of whether a replacement power alternative is implemented, and the impacts discussed previously that would be associated with continued operation of the CCS would apply to this alternative. The NRC staff concludes that impacts of a natural gas alternative on aquatic resources would be MODERATE to LARGE in the local environs of the plant, due to the permanent loss of aquatic habitats during plant siting and the potential for additional disturbance or loss of aquatic habitats during pipeline construction. The exact level of impact would depend on whether the chosen plant site and pipeline route results in the permanent loss, impairment, fragmentation, or reduced ecosystem function of affected aquatic habitats.

4.7.6 Combination Alternative (Natural Gas Combined-Cycle and Solar Photovoltaic Generation)

The NRC staff did not identify any impacts to aquatic resources for the natural gas portion of the combination alternative beyond those already discussed above for the natural gas-only alternative. For the solar portion of the combination alternative, the exact level of disturbance or degradation that aquatic habitats would experience would depend on the specific siting of solar panels and infrastructure. Given the large area of land that the solar component would require (approximately 1,400 ac (570 ha) for three offsite solar units, in total) and the prevalence of wetlands, mangrove forests, and other important aquatic habitats within the region where the solar units would be sited, construction would likely result in permanent loss or impairment of aquatic habitats. As described above, the CCS would continue to operate regardless of whether a replacement power alternative is implemented, and the impacts discussed previously that would be associated with continued operation of the CCS would apply to this alternative. The NRC staff concludes that impacts of a combination alternative on aquatic resources would be MODERATE to LARGE in the local environs of the plant, due to the permanent loss of aquatic habitats during natural gas plant and solar panel siting. The exact level of impact would depend on whether the chosen natural gas plant site and solar panel sites result in the permanent loss, impairment, fragmentation, or reduced ecosystem function of affected aquatic habitats.

4.7.7 Cooling Water System Alternative

The NRC staff did not identify any impacts to aquatic resources for the cooling water system alternative beyond those discussed in the impacts common to all replacement power alternatives. As described above, the CCS would continue to operate regardless of whether cooling towers are constructed to support Turkey Point Units 3 and 4, and the impacts discussed previously that would be associated with continued operation of the CCS would apply to this alternative. Construction of cooling towers on the Turkey Point site would result in the permanent loss or impairment of sensitive aquatic habitats and could affect ecosystem function and connectivity. Therefore, the NRC staff concludes that the impacts of implementing the cooling water system alternative on aquatic resources would be MODERATE in the local environs of the plant.

4.8 <u>Special Status Species and Habitats</u>

This section describes the potential special status species and habitats impacts of the proposed action (subsequent license renewal) and alternatives to the proposed action.

4.8.1 Proposed Action

Table 4-2 identifies the one Turkey Point site-specific (Category 2) issue related to special status species and habitats applicable to the area during the subsequent license renewal term. This issue is analyzed below.

4.8.1.1 Federally Listed Species and Critical Habitats Protected Under the Endangered Species Act

Federally Listed Species and Critical Habitats under U.S. Fish and Wildlife Service Jurisdiction

Section 3.8, "Special Status Species and Habitats," in this SEIS describes 42 federally listed species solely under the FWS's jurisdiction that occur in the action area. In that section, the NRC staff concludes that 25 of these species would not occur in the action area because those species are extirpated from Miami-Dade County, are not known to occur within Miami-Dade County, or no suitable habitat occurs within the action area. An additional four species are under the shared jurisdiction of the FWS and the National Marine Fisheries Service (NMFS). The NRC staff has determined that continued operation of Turkey Point Units 3 and 4 would have no effect on any portions of these species' life cycles that are under the FWS's jurisdiction (NRC 2018g). In addition, two species are listed because of similarity of appearance to other listed species and, therefore, are not subject to the Endangered Species Act of 1973, as amended (ESA), Section 7 consultation requirement.

In a separate biological assessment, the NRC staff (2018n) analyzed the potential impacts of the proposed Turkey Point subsequent license renewal on the American crocodile, the eastern idndigo snake (*Drymarchon corais couperi*), and the remaining 13 species, as well as on designated critical habitat of the American crocodile and West Indian manatee (*Trichechus manatus*). The NRC staff incorporates its biological assessment into this SEIS by reference. The NRC staff's ESA effect determinations for each species are identified below in Table 4-4.

The NRC staff (2018) submitted its biological assessment to the FWS for review on December 19, 2018. In the accompanying letter, the staff requested to initiate formal consultation under 50 CFR 402.14 for the American crocodile and eastern indigo snake, and the staff requested the FWS's concurrence with the NRC staff's "may affect, but is not likely to adversely affect" determinations for other federally listed species in accordance with 50 CFR 402.12(j).

On February 25, 2019, the NRC staff and the FWS (2019a) held a teleconference to discuss the NRC staff's effect determinations for certain federally listed species. Based on those discussions, on February 26, 2019, the NRC staff (2019c) revised its impact determinations from "may affect, but is not likely to adversely affect" to "no effect" for the following species: Florida bonneted bat (*Eumops floridanus*), piping plover (*Charadrius melodus*), Everglades snail kite (*Rostrhamus sociabilis*), Kirtland's warbler (*Setophaga kirtlandi*), Blodgett's silverbush (*Argythamnia blodgettii*), Cape Sable thoroughwort (*Chromolaena frustrata*), Florida semaphore cactus (*Consolea corallicola*), sand flax (*Linum arenicola*), and Florida bristle fern (*Trichomanes punctatum* ssp. *floridanum*).

Consultation between the NRC and the FWS continued until the FWS (2019b) issued a new biological opinion for Turkey Point on July 25, 2019. After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the action, any effects of interrelated and interdependent activities, and cumulative effects, the FWS (2019b) concluded in the biological opinion that the continued operation of Turkey Point through the duration of the proposed subsequent license renewal period is not likely to jeopardize the continued existence of the American crocodile or eastern indigo snake and will not adversely modify the critical habitat of the American crocodile. The biological opinion includes an Incidental Take Statement that applies to the American crocodile and eastern indigo snake during operation of Turkey Point through the duration of the proposed subsequent license renewal periods (i.e., through July 19, 2052, for Unit 3 and through April 10, 2053, for Unit 4). The Incidental Take Statement exempts incidental take that may occur from:

- harm from habitat loss (American crocodile),
- injuries or mortalities from vehicle collisions (American crocodile), and
- mortality from vegetation maintenance (eastern indigo snake).

The opinion specifies allowable numbers for such incidental take to be as follows.

- One American crocodile causal mortality per calendar year
- One indigo snake causal mortality every two calendar years

The opinion also includes the following Reasonable and Prudent Measure that the FWS (2019b) determined to be necessary or appropriate to minimize the impact of the amount of extent of incidental take.

> Minimize the adverse effects of the ongoing operation of the Turkey Point Power facility by implementing measures to increase employee awareness of the presence of the crocodile and indigo snake on the site.

The FWS (2019b) states that this measure is necessary and appropriate to reduce take and to minimize the direct and indirect effects of the proposed project on the American crocodile and eastern indigo snake. The FWS identified five Terms and Conditions to implement this Reasonable and Prudent Measure, which it described as follows (FWS 2019b).

1) Continue crocodile nest and hatchling monitoring at Turkey Point for the duration of the NRC's licensed operations, or unless otherwise agreed upon by FPL, the Service, the NRC, and any relevant researchers. Every two years, FPL, the Service, the NRC, and any relevant researchers will meet to discuss the monitoring methods and the need for continuation.
2) Continue to conduct employee training for crocodiles and indigo snake awareness and posts educational signs around the plant.
3) The applicant must maintain four warning signs labeled as "Slow Crocodile Crossing" along Bechtel Road near the test canals on the Turkey Point Power Plant site. The signs will be installed at approximately 500-foot intervals. Based on our field inspection of the Turkey Point Power Plant site, we are aware that FPL has already installed these signs.
4) Provide an informational bulletin on the crocodile to all employees at the Turkey Point Power Plant once every 6 months. The bulletin should remind employees that crocodiles occur on the Turkey Point Facility grounds, include a photograph of an crocodile, and note that crocodile hatchlings can be small (12 to 18 inches total length) making them more difficult to detect. In addition, the bulletin should remind employees to be alert for crocodiles when driving or conducting activities on the site, to observe speed limits at all times, to not interact with a crocodile in any way, and to contact their supervisor if a crocodile is observed on or near a road.

5) Conduct a presentation on the crocodile and indigo snakes twice a year at the monthly safety meeting that all plant personnel are required to attend. The presentations will be made during the crocodile mating and nesting season when the activity of crocodiles at the site is greatest. The presentation will focus on the identification of crocodiles and indigo snakes, and areas on the Turkey Point Power Plant site where crocodiles may occur. The presentation will also remind employees to: be alert for crocodiles and indigo snakes when driving or conducting activities on the site, observe speed limits at all times, not interact with a crocodile or indigo snake in any way, and contact their supervisor if a crocodile or indigo snake is observed on or near a road.

The Terms and Conditions are nondiscretionary and must be undertaken by the NRC so that they become binding conditions of the renewed licenses, if granted, for the exemption in Section 7(o)(2) of the ESA to apply. Accordingly, the NRC staff will incorporate these terms and conditions into a license condition for the proposed subsequent renewed licenses, if issued.

With respect to all other federally listed species and critical habitats that occur or have the potential to occur in the action area, the FWS (2019b) concurred with the NRC staff's "may affect, but is not likely to adversely affect" determinations. The FWS (2019b) documented its concurrence in the body of the biological opinion. The FWS did not evaluate or make conclusions regarding those species for which the NRC staff made "no effect" determinations, and the ESA does not require Federal agencies to consult on such species or obtain FWS concurrence with such findings. Table 4-4 identifies the FWS's conclusions for each federally listed species and designated critical habitat.

The FWS's issuance of the July 25, 2019, biological opinion concluded the ESA Section 7 consultation for the proposed Turkey Point subsequent license renewal. Appendix C.1 describes the NRC staff's consultation with the FWS.

<u>Federally Listed Species and Critical Habitats under National Marine Fisheries Service Jurisdiction</u>

Section 3.8, "Special Status Species and Habitats," describes six federally listed species under the NMFS's jurisdiction that occur in the action area: loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), leatherback sea turtle (*Dermochelys coriacea*), hawksbill sea turtle (*Eretmochelys imbricata*), Kemp's ridley sea turtle (*Lepidochelys kempii*), and smalltooth sawfish (*Pristis pectinata*). In that section, the NRC staff concludes that all of these species occur in the action area because they inhabit Biscayne Bay but that none occur on the Turkey Point site itself, including within the CCS. The NRC staff analyzes the potential impacts of the proposed Turkey Point subsequent license renewal on these six species below. Table 4-5, below, summarizes the NRC staff's ESA effect determination for each species. Appendix C.1 describes the NRC staff's consultation with the NMFS.

Table 4-4 Effect Determinations for Federally Listed Species Under U.S. Fish and Wildlife Service Jurisdiction

Species	Common Name	Federal Status[a]	NRC Staff Effect Determination[b]	FWS Conclusion[c]
Mammals				
Eumops floridanus	Florida bonneted bat	FE	no effect[e]	n/a[f]
Puma concolor coryi	Florida panther	FE	may affect, but is not likely to adversely affect	may affect, but is not likely to adversely affect
Puma concolor (all sub species except *coryi*)	puma	SAT	n/a[e]	n/a[e]
Trichechus manatus	West Indian manatee	FT	may affect, but is not likely to adversely affect no adverse modification to designated critical habitat	may affect, but is not likely to adversely affect no adverse modification to designated critical habitat[g]
Birds				
Ammodramus maritimus mirabilis	Cape Sable seaside sparrow	FE	no effect	n/a[f]
Ammodramus savannarum	Florida Grasshopper sparrow	FE	no effect	n/a[f]
Aphelocoma coerulescens	Florida scrub-jay	FT	no effect	n/a[f]
Caladris rufa	red knot	FT	may affect, but is not likely to adversely affect	may affect, but is not likely to adversely affect
Campephilus principalis	ivory-billed woodpecker	FE	no effect	n/a[f]
Charadrius melodus	piping plover	FT	no effect[d]	n/a[f]
Mycteria americana	wood stork	FT	may affect, but is not likely to adversely affect	may affect, but is not likely to adversely affect
Picoides borealis	red-cockaded woodpecker	FE	no effect	n/a[f]
Rostrhamus sociabilis	Everglades snail kite	FE	no effect[d]	n/a[f]
Setophaga kirtlandi	Kirtland's warbler	FE	no effect[d]	n/a[f]
Vermivora bachmani	Bachman's warbler	FE	no effect	n/a[f]

Species	Common Name	Federal Status[(a)]	NRC Staff Effect Determination[(b)]	FWS Conclusion[(c)]
Reptiles				
Alligator mississippiensis	American alligator	SAT	n/a[(e)]	n/a[(e)]
Crocodylus acutus	American crocodile	FT	likely to adversely affect adverse modification to designated critical habitat	not likely to jeopardize the continued existence of no adverse modification to designated critical habitat
Drymarchon corais couperi	eastern indigo snake	FT	likely to adversely affect	not likely to jeopardize the continued existence of
Invertebrates				
Anaea troglodyta floridalis	Florida leafwing butterfly	FE	no effect	n/a[(f)]
Cyclargus thomasi bethunebakeri	Miami blue butterfly	FE	no effect	n/a[(f)]
Heraclides aristodemus ponceanus	Schaus swallowtail butterfly	FE	no effect	n/a[(f)]
Orthalicus reses	Stock Island Tree Snail	FT	no effect	n/a[(f)]
Strymon acis bartrami	Bartram's hairstreak butterfly	FE	no effect	n/a[(f)]
Flowering Plants				
Amorpha crenulata	crenulate lead-plant	FE	no effect	n/a[(f)]
Argythamnia blodgettii	Blodgett's silverbush	FT	no effect[(d)]	n/a[(f)]
Brickellia mosieri	Florida brickell-bush	FE	no effect	n/a[(f)]
Chamaesyce deltoidea ssp. deltoidea	deltoid spurge	FE	no effect	n/a[(f)]
Chamaesyce deltoidea pinetorum	pineland sandmat	FT	no effect	n/a[(f)]
Chamaesyce garberi	Garber's spurge	FT	no effect	n/a[(f)]
Chromolaena frustrata	Cape Sable thoroughwort	FE	no effect[(d)]	n/a[(f)]
Consolea corallicola	Florida semaphore cactus	FE	no effect[(d)]	n/a[(f)]
Cucurbita okeechobeensis ssp. okeechobeensis	Okeechobee Gourd	FE	no effect	n/a[(f)]
Dalea carthagenensis floridana	Florida prairie-clover	FE	no effect	n/a[(f)]
Digitaria pauciflora	Florida pineland crabgrass	FT	no effect	n/a[(f)]

Species	Common Name	Federal Status[(a)]	NRC Staff Effect Determination[(b)]	FWS Conclusion[(c)]
Galactia smallii	Small's milkpea	FE	no effect	n/a[(f)]
Jacquemontia reclinata	beach jacquemontia	FE	no effect	n/a[(f)]
Linum arenicola	sand flax	FE	no effect[(d)]	n/a[(f)]
Linum carteri carteri	Carter's small-flowered flax	FE	no effect	n/a[(f)]
Polygala smallii	tiny polygala	FE	no effect	n/a[(f)]
Sideroxylon reclinatum ssp. austrofloridense	Everglades bully	FT	no effect	n/a[(f)]
Warea carteri	Carter's mustard	FE	no effect	n/a[(f)]
Ferns				
Trichomanes punctatum ssp. *floridanum*	Florida bristle fern	FE	no effect[(d)]	n/a[(f)]

[(a)] SAT = federally listed due to similarity of appearance to another listed species, FE = federally listed as endangered, FT = federally listed as threatened at 50 CFR Part 17, "Endangered and Threatened Wildlife and Plants," under the provisions of the ESA.

[(b)] The NRC staff's effect determinations are documented in the staff's December 19, 2018, biological assessment (NRC 2018n) except as noted in footnote (d) below.

[(c)] The FWS's conclusions are documented in its July 25, 2019, biological opinion (FWS 2019b).

[(d)] The NRC staff revised its impact determination from "may affect, but is not likely to adversely affect" to "no effect" for this species in consultation with the FWS. Emails exchanged between the two agencies (FWS 2019a; NRC 2019c) document the NRC staff's revised determination. The FWS's biological opinion also documents the staff's revised determination in the section titled, "Consultation history."

[(e)] The ESA does not require Federal agencies to consult under Section 7 for species listed due to similarity of appearance with another species. Accordingly, the NRC staff has not made an ESA effect determination for these species, and the FWS did not address it in its biological opinion.

[(f)] The ESA does not require Federal agencies to obtain FWS concurrence with "no effect" determinations, and the FWS did not evaluate or make conclusions for this species in its biological opinion.

[(g)] The FWS clarified its conclusion for designated critical habitat of the West Indian manatee in an August 16, 2019, email (FWS 2019c).

Table 4-5 Effect Determinations for Federally Listed Species Under National Marine Fisheries Service Jurisdiction

Species	Common Name	Federal Status[a]	NRC Staff Effect Determination	NMFS Conclusion
Sea Turtles				
Caretta caretta	loggerhead	FT	may affect, but is not likely to adversely affect	TBD[c]
Chelonia mydas	green	FT[b]	may affect, but is not likely to adversely affect	TBD[c]
Dermochelys coriacea	leatherback	FE	may affect, but is not likely to adversely affect	TBD[c]
Eretmochelys imbricata	hawksbill	FE	may affect, but is not likely to adversely affect	TBD[c]
Lepidochelys kempii	Kemp's ridley	FE	may affect, but is not likely to adversely affect	TBD[c]
Fish				
Pristis pectinata	smalltooth sawfish	FE[b]	may affect, but is not likely to adversely affect	TBD[c]

(a) FE = federally listed as endangered and FT = federally listed as threatened at 50 CFR Part 17, "Endangered and Threatened Wildlife and Plants," under the provisions of the ESA.

(b) The identified Federal status applies to the following distinct population segment(s) (DPS): Northwest Atlantic and South Atlantic DPSs of the green turtle and United States DPS of the smalltooth sawfish.

(c) The NMFS's conclusion for this species is to be determined (TBD) because consultation between the NRC staff and the NMFS continues at this time. The results of this consultation will be reported in the NRC's Record of Decision for the proposed Turkey Point subsequent license renewal.

Impingement, Entrainment, and Thermal Effects

In the GEIS (NUREG-1437) (NRC 2013a), the NRC staff identified a number of issues (or impacts) that the aquatic ecological environment could experience as a result of license renewal of a nuclear plant. These impacts, as they apply to the proposed Turkey Point subsequent license renewal, are identified in Table 4-1 and Table 4-2. As described in Section 4.7, "Aquatic Resources," because the CCS does not directly withdraw from or discharge to any other surface waters, the effects of impingement, entrainment, and thermal discharges are not applicable for aquatic biota in Biscayne Bay or any other natural waterbodies. Thus, federally listed sea turtles and smalltooth sawfish occurring in the action area would not be subject to these impacts.

Barge Traffic

Barge traffic associated with subsequent license renewal has the potential to impact sea turtles and smalltooth sawfish inhabiting Biscayne Bay. Continued operation of Turkey Point during the subsequent license renewal term would necessitate infrequent deliveries of large parts and equipment to the Turkey Point site. FPL (2018g) estimates that up to five barges in a single year at intervals of 4 to 5 years would travel to and from Turkey Point during the proposed subsequent license renewal term. This level of vessel traffic would include combined deliveries associated with Turkey Point Units 3 and 4; Turkey Point Units 1, 2, and 5; and the onsite independent spent fuel storage installation (FPL 2018g).

Sea turtles and smalltooth sawfish in Biscayne Bay could be injured or killed during interactions with barge vessels as the vessels travel through the Bay. However, the infrequency of vessel traffic and the ability of sea turtles and smalltooth sawfish to move away from vessels to avoid impact make such effects extremely unlikely to occur. The NMFS assessed the impacts of barge traffic, among other effects, as part of its ESA, Section 7 consultation with the NRC for the proposed construction of Turkey Point Units 6 and 7 in 2017. Construction of the two new units would involve regular barge deliveries as well as pile driving and basin dredging, all of which the NMFS (2017a) found to be discountable. The NRC staff finds the same conclusion to be reasonable for the proposed Turkey Point Units 3 and 4 subsequent license renewal because this action would require much less frequent barge deliveries and would not involve any dredging or other in-water work. Additionally, the NRC staff is not aware of any sea turtle or smalltooth sawfish injuries or mortalities associated with Turkey Point barge traffic since the units began operating in 1972 (Unit 3) and 1974 (Unit 4). Compared to the original license and initial renewed license terms, barge traffic would continue at similar or less frequent rates during the proposed subsequent license renewal term. Accordingly, the NRC staff finds this potential impact to be discountable.

Biscayne Bay Water Quality

During the NEPA scoping and DSEIS comment periods, the NRC staff received comments recommending that the staff consider the potential impacts of interactions between the CCS and nearby surface waterbodies on federally listed species. The commenters' suggestions stemmed primarily from the concern that contaminants originating from the CCS could affect water quality in Biscayne Bay, which would in turn affect federally listed species present in the action area. The NRC staff evaluates this potential impact below. The NRC staff (2019g) also prepared detailed analyses of this issue in response to the NMFS's requests for additional information during its Section 7 consultation with the NMFS. The staff has updated this SEIS to reflect these more detailed analyses. Additionally, the staff updated the sections below to reflect the most recently available water quality monitoring data that became available following the staff's issuance of the DSEIS.

<u>Background on Nonradiological and Radiological Contaminants</u>. In the GEIS (NRC 2013a), the NRC staff evaluated the effects that nonradiological and radiological contaminants contained in nuclear plant effluent discharges may have on the aquatic environment under the following Category 1 license renewal issues:

- effects of nonradiological contaminants on aquatic organisms
- exposure of aquatic organisms to radionuclides

The NRC (2013a) determined that the impacts of these issues would be SMALL during the license renewal period of a nuclear power plant. In Table B-1 of 10 CFR Part 51, Appendix B, the NRC defines "SMALL" to mean that environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. Because these potential effects that apply to all nuclear plants (rather than only to Turkey Point), the NRC staff bases its GEIS conclusions on factors that apply at all nuclear plants. For instance, with respect to nonradiological contaminants, a primary factor that led to the staff's conclusion of SMALL is that in order to operate a nuclear plant, licensees must comply with the Clean Water Act (CWA), including requirements imposed by the EPA or the State, as part of the NPDES program under Section 402 of the Act and State water quality certification requirements under Section 401 of the Act. If these water quality criteria are not violated, the NRC assumes that nonradiological contaminant discharges would not significantly affect the aquatic environment. The NRC staff's analysis relating to the effects of nonradiological contaminants on aquatic organisms appears on pages 4-103 to 4-105 of the GEIS (NRC 2013a). For the proposed Turkey Point subsequent license renewal, the NRC staff did not identify any new and significant information during its environmental review related to the effects of nonradiological contaminants on aquatic organisms beyond what is described in the GEIS. The NRC staff adopted the GEIS's conclusions of SMALL for this issue in Section 4.7.1 of this SEIS. Such an effect level would equate to "insignificant" in ESA terminology (i.e., the effects would never reach the scale where a take would occur and, based on best judgement, a person would not be able to meaningfully measure, detect, or evaluate such effects).

With respect to radiological contaminants, the NRC staff uses DOE (2019) guidelines to evaluate the potential effects of exposure of aquatic organisms to radionuclides during a nuclear plant license renewal term. The DOE developed and published a screening methodology that includes biota concentration guides (BCGs) for surface water, sediment, and soil. The DOE developed its BCGs to be conservatively protective of nonhuman biota for 23 radionuclides, including tritium (H-3), based on limiting the potential radiological dose rate to the most sensitive receptors. For each radionuclide and exposure pathway (i.e., surface water, sediment, and soil), the most sensitive receptor (or reference organism) may be an aquatic, terrestrial, or riparian animal, or a terrestrial plant. Specific to aquatic animal reference organisms, the DOE uses a dose rate criterion of ≤1 rad per day (rad/d) of absorbed dose. This dose rate criterion can be applied within the DOE's graded approach to determine whether radionuclide concentrations at a specific site are likely to result in doses exceeding DOE guidelines. If the graded approach demonstrates that the absorbed dose would be ≤1 rad/d, aquatic biota would not experience negative population-level effects. In the GEIS, the NRC uses the DOE's dose rate criterion of ≤1 rad/d and the DOE's graded approach to conclude that the impacts of exposure of aquatic organisms to radionuclides resulting from license renewal of a nuclear plant would be SMALL. The NRC staff's full analysis relating to exposure of aquatic organisms to radionuclides appears on pages 4-105 to 4-107 of the GEIS. For the proposed Turkey Point license renewal, the NRC staff did not identify any new and significant information during its review related to the exposure of aquatic organisms to radionuclides beyond what is described in the GEIS. The NRC staff adopted the GEIS's conclusions of SMALL for this issue in Section 4.7.1 of the SEIS. As explained above, this effect level would equate to "insignificant" in ESA terminology.

Separate from the above-described analyses, the impacts of license renewal on federally listed species is a Category 2 (site-specific) issue in the GEIS that requires a unique analysis for each license renewal. The remainder of this section considers the impacts that sea turtles and smalltooth sawfish inhabiting Biscayne Bay may experience at the individual or species level resulting from exposure to nonradiological and radiological contaminants associated with continued operation of Turkey Point during the proposed license renewal period.

<u>Exposure Pathway</u>. At Turkey Point, the potential pathway for exposure of aquatic organisms that inhabit Biscayne Bay to contaminants originating from the CCS is indirect and complex. As described in Section 3.5.1, "Surface Water Hydrology," of this SEIS, the CCS is situated above the Biscayne aquifer. The porous nature of the limestone bedrock that forms the Biscayne aquifer results in some groundwater exchange between the CCS and the aquifer. This

exchange of groundwater between the CCS and the Biscayne aquifer creates a pathway through which the CCS may influence Biscayne Bay. Groundwater under the Turkey Point site flows east (towards Biscayne Bay) or west (inland and away from the Bay) depending on the head levels in the aquifer relative to the water levels in Biscayne Bay. Within the larger regional context, South Florida's water is highly influenced by a complex system of crisscrossing canals that drain surface waters from the land for agricultural and urban use, provide flood control, and discharge freshwater into Biscayne Bay and Card Sound. The State manages the canal system as a coastal control structure to maintain relatively high water levels along the coast and prevent saltwater intrusion within near-surface groundwater aquifers. The State of Florida and Miami-Dade County have required FPL to take actions to abate hypersaline water discharges from the CCS and to actively remediate the hypersaline groundwater west and north of FPL's property. Many of FPL's current and ongoing actions to address groundwater quality are specified in a June 2016 Consent Order with the FDEP and in an October 2015 Consent Agreement with the Miami-Dade County Department of Environmental Resources Management (DERM) (see Section 3.5.2.2, "Groundwater Quality" for more detailed information). Both the Consent Order and Consent Agreement contain requirements that aim to ensure that the CCS does not adversely affect the region's surface waters. Thus, the potential for contaminants originating from the CCS to affect nearby surface water quality depends on many factors, including Biscayne Bay water conditions, groundwater head levels, freshwater inflow from precipitation, the State's management of South Florida's regional canal system, and FPL's implementation of State- and County-imposed requirements.

<u>Water Quality Monitoring Data</u>. As part of the requirements of the State's Consent Order, FPL maintains an extensive water quality monitoring program. FPL monitors the CCS, Biscayne Bay, Card Sound, and other nearby waterbodies for ammonia, nitrogen, phosphorus, and chloride, among other nutrients and parameters. Additionally, FPL conducts ecological monitoring semiannually in Biscayne Bay and mangrove areas and quarterly in marsh areas. To date, FPL's monitoring data indicate no discernable ecological impact on the areas surrounding the CCS and no clear evidence of CCS water in the surrounding marsh and mangrove areas or in Biscayne Bay from a groundwater pathway (E&E 2017; FPL 2018o). FPL's monitoring plan and associated results are described in more detail in Section 3.5.1, "Surface Water Hydrology" of this SEIS.

While there is no evidence that the CCS is affecting Biscayne Bay, Miami-Dade County has expressed concern that groundwater underlying the CCS may be contributing nutrients (e.g., ammonia) to manmade canals adjacent to the CCS. The waters of these (non-CCS) canals are hydrologically connected to the CCS through the Biscayne aquifer and are hydrologically connected to Biscayne Bay through surface water flow (see Figure 3-4, "Cooling Canal System and Adjacent Canals"). In July 2017, the Miami-Dade County Division of Environmental Resource Management (DERM) found elevated concentrations of ammonia exceeding the applicable county surface water standard at certain sampling locations within certain canals adjacent to the CCS (MDC 2018a). The relevant sampling locations at which elevated ammonia levels were measured were at the Barge Basin, Turtle Point Canal, Card Sound Canal, S-20 Get Away Canal, and the Sea-Dade Canal. The elevated ammonia values appeared in bottom samples where dissolved oxygen was less than 1.0 mg/L (FPL 2018r). Ammonia levels in the middle and upper portions of the water column were compliant with county ammonia standards except for middle samples in the Turtle Point Canal where dissolved oxygen levels were also less than 1.0 mg/L (FPL 2018r). Thus, ammonia in the canals stratified such that concentrations exceeding county standards generally occurred only in the bottom of the water column.

In a letter to FPL on this subject, DERM stated that ammonia at these locations may be attributable to a combination of several sources, including both operation of the CCS and other unrelated factors (MDC 2018a). For instance, several bottom samples within these canals exhibited total nitrogen concentrations that greatly exceeded total nitrogen concentrations measured in the CCS and in groundwater beneath the CCS during the same period (FPL 2018r). However, this suggests that sources external to the CCS are contributing nitrogen to the canals. Because these regions of the canals are stagnant and exhibit low dissolved oxygen, decomposition of plant and animal material in these stagnant, anoxic areas creates extra nitrogen that is not able to disperse or be flushed out of the canals due to little or no mixing of the canals with other surface waters. This extra nitrogen may then contribute to ammonia formation and subsequent accumulation and may ultimately play a role in the observed exceedances of county ammonia standards in the bottom of the canals. Nevertheless, because the DERM believed that the CCS may have been one source contributing to the elevated ammonia levels, it required FPL to submit and implement a mitigation plan to address potential CCS nutrient impacts to groundwater and surface water resources beyond the boundaries of the CCS.

FPL (2018r) submitted its mitigation plan to the DERM in October 2018. In the letter accompanying the plan, FPL (2018r) explained that the data upon which the DERM had relied in making its findings do not definitively delineate the contribution of groundwater underlying the CCS to ammonia levels in the surrounding waters. FPL (2018r) stated that its data demonstrate that at most, groundwater underlying the CCS could have contributed 2 percent or less of the observed ammonia values in the samples taken from the canals. As such, FPL (2018r) concluded that the contribution of groundwater beneath the CCS to ammonia concentrations in adjacent surface waters, if any, is negligible. Nevertheless, the NRC staff undertook the following qualitative evaluation of the potential impacts of elevated ammonia levels on listed species to ensure that the staff appropriately considered all potential impacts of Turkey Point subsequent license renewal on listed species that inhabit Biscayne Bay.

<u>Potential Effects of Ammonia on Listed Species</u>. Elevated ammonia levels are of concern in aquatic environments because when ammonia is present at high enough levels in the environment, aquatic organisms have difficulty completely excreting excess ammonia from their bodies. This can lead to toxic build-up, health and fitness effects, and potentially death. Several water quality parameters, including pH, temperature, and salinity; the rate or duration of exposure; and a species' specific physiobiology affect the extent to which an organism experiences toxicity from a given level of ammonia.

With respect to sea turtles, data on the effects of ammonia are not currently available. In the absence of species-specific information, the NRC assumes that the relevant State water quality criteria are reasonably protective of sea turtles because under Section 303(c) of the Clean Water Act, the EPA or the States are required to adopt water quality standards to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. For delegated States, the EPA must periodically certify that a State's water quality criteria, and any revisions thereto, protect the designated uses of the waterbody and that the standards are consistent with, or more protective than, the EPA's national recommended aquatic life criteria. Therefore, if waters inhabited by sea turtles meet State water quality criteria for ammonia, the NRC staff assumes that there would be no lethal effects or impairment to growth, survival, or reproduction to sea turtle individuals. As described above, the DERM identified a few sampling locations where, in 2017, the total ammonia concentrations exceeded the applicable Miami-Dade County surface water standard. However, the sampled locations were in stagnant, or dead-end canals where sea turtles are unlikely to be present rather than in Biscayne Bay itself were sea turtles are more likely to be present. Even if sea turtles were to be present in the canals, exposure time would be limited because sea turtles are expected to only occur transiently and for short durations, if at all, in these areas.

Additionally, as described above, the DERM is requiring FPL to take action to restore water quality in the canal areas with elevated ammonia such that ammonia is not expected to be a long-term issue. As also described above, FPL (2018r) submitted a mitigation plan to the DERM in October 2018, to address the potential impacts of CCS operation on groundwater and surface water resources beyond the boundaries of the CCS. The mitigation plan specifies FPL's CCS canal practices, external canal practices, and applicable monitoring and reporting. One FPL action related to the mitigation plan entails the restoration and partial filling of the Barge Canal Turning Basin and the planting of mangroves in and partial filling of the Turtle Point Canal (FPL 2018r). These restoration activities will improve water flow in these canals, which will reduce the potential for ammonia and other nutrients to accrue in these areas in the future. FPL (2018r) began the canal restoration and partial filling project in October 2018. FPL (2019e) completed Turtle Point Canal restoration in April 2019 and completed the Barge Canal Turning Basin in September 2019. The 2016 Consent Order (FDEP 2016a) between FPL and the FDEP also requires FPL to undertake and complete this project. Section 3.5.1.4 of this SEIS discusses this project in more detail under "Ammonia and Nutrients within Biscayne Bay and Card Sound." These fill and restoration projects will reduce access of sea turtles to these areas because the subject areas will be filled. The projects will also improve flow such that decomposing plant and animal matter and stagnant conditions in the canals should no longer exist.

As discussed elsewhere in this SEIS, another action that FPL (2018r) is taking is the implementation of its groundwater recovery well system, which removes up to 15 mgd (56,800 m^3/day) of hypersaline groundwater from the base of the Biscayne aquifer via a series of 10 extraction wells along the western edge of the CCS and Palm Drive. FPL (2018r) reported that these extractions had also removed approximately 27,600 lbs (12,520 kg) of ammonia from groundwater beneath the CCS as of October 2018. Further, no contaminants associated with the CCS, including ammonia, have been found in Biscayne Bay itself where sea turtles are more likely to be present. In summary, the very low likelihood of sea turtles to be exposed to elevated ammonia levels and the short duration of potential exposure is unlikely to result in measurable effects on sea turtles. Additionally, FPL's continued implementation of the mitigation plan described above would further reduce the contribution, if any, of the CCS to elevated ammonia levels in surrounding waters to which sea turtles could be exposed.

Toxicity data for smalltooth sawfish exposure to ammonia (or for taxonomically related species that would serve as a reasonable surrogate) are also unavailable. However, the NRC staff assumes that, as with sea turtles, the State water quality criteria are reasonably protective of smalltooth sawfish. Additionally, ureotelic species (species that excrete most of their waste nitrogen in the form of urea in the urine), such as the smalltooth sawfish, regulate the ion concentrations in their body fluids to maintain osmotic balance with their external environment, which reduces the influx of ammonia from the external environment (NMFS 2016a). Ureotelic species also convert ammonia to urea and native tri-methyl amine oxide, which counteracts its toxicity (NMFS 2016a). As such, smalltooth sawfish are expected to be less vulnerable to ambient ammonia than many other aquatic species. In a 2016 biological opinion on the EPA's approval of Florida water quality standards under Section 303(c) of the Clean Water Act, the NMFS (2016a) concluded that ammonia concentrations were not likely to adversely affect the survival or fitness of smalltooth sawfish individuals because responses to anticipated ammonia concentrations from the implementation of the revised standards would be insignificant based on what is known about nitrogen metabolism and ion regulation for ureotelic elasmobranch species like the smalltooth sawfish. Further, smalltooth sawfish are unlikely to be present in the canals where elevated ammonia levels were measured. Even if smalltooth sawfish were to be present in the manmade canals adjacent to the CCS, exposure time would be limited because individuals are expected to only occur transiently and for short durations, if at all, in these areas. Based on this information, the NRC staff finds that smalltooth sawfish are unlikely to be measurably affected. Additionally, FPL's continued implementation of the mitigation plan described above would further reduce the CCS's contribution, if any, to elevated ammonia levels in surrounding waters to which smalltooth sawfish could be exposed. FPL's completion of the previously described fill and restoration projects will reduce access of smalltooth sawfish to these areas.

The NRC staff concludes that the potential for sea turtles or smalltooth sawfish to be exposed to elevated ammonia levels associated with the continued operation of Turkey Point and the CCS is unlikely based on the following.

- Available monitoring data suggest that the contribution of groundwater beneath the CCS to ammonia concentrations in adjacent surface waters, if any, is negligible.
- Sea turtles are unlikely to be present in the stagnant or dead-end canals where elevated levels of ammonia have been observed.
- Smalltooth sawfish are less vulnerable to ambient ammonia than many other aquatic species because of how they metabolize nitrogen. Smalltooth sawfish are also unlikely to be present in the canals where elevated levels of ammonia have been observed.
- FPL has completed fill and restoration of Turtle Point Canal and restoration of the Barge Canal Turning Basin. These projects have limited access to the previously stagnant regions of the canals and will continue to improve flow to the remaining portions of the canals.
- FPL will continue to implement mitigation to further reduce the contribution, if any, of the CCS to elevated ammonia levels in surrounding waters to which sea turtles or smalltooth sawfish could be exposed.

Any negligible ammonia exposure, if such exposure were to occur, would not result in effects that would be able to be meaningfully measured, detected, or evaluated. The NRC staff concludes that such effects would, therefore, be insignificant.

<u>Potential Effects of Other Nonradiological Contaminants on Listed Species</u>. The NRC staff did not identify any evidence that the CCS may be contributing to any other nonradiological contamination, such as nitrogen, phosphorus, or salinity, in any surface waters outside of the CCS beyond what the staff describes above relating to ammonia. Additionally, any potential future water quality effects on sea turtles and smalltooth sawfish would be limited because the NRC staff assumes that FPL will adhere to, and that the State and County will enforce, the various mitigation requirements in the 2016 FDEP Consent Order (FDEP 2016a) and 2015 DERM Consent Agreement (MDC 2015a) such that nonradiological contaminants associated with the CCS will not discernably affect the aquatic ecology of Biscayne Bay over the course of the proposed subsequent license renewal term. The NRC staff concludes that the potential for sea turtles or smalltooth sawfish to be exposed to nonradiological contaminants associated with the continued operation of Turkey Point and the CCS would not result in effects that would be able to be meaningfully measured, detected, or evaluated. The NRC staff concludes that such effects would, therefore, be insignificant.

Potential Effects of Radiological Contaminants on Listed Species. With respect to the potential impacts of radiological contaminants on listed species in the action area, the radionuclide of concern is tritium. Tritium is a radioactive isotope of hydrogen that has one proton and two neutrons. It occurs both naturally and as a by-product of nuclear reactor operation. In water, tritium binds with oxygen to form tritiated water (H_3O), which behaves in the environment identical to a normal water molecule (H_2O). Tritium is a relatively weak source of beta radiation; the beta particle itself does not have enough energy to penetrate human skin, but tritium molecules can enter humans and other organisms through inhalation or ingestion. Tritium has a half-life of 12.3 years. However, if ingested, the human body excretes half the ingested tritium within 10 days (NRC 2019h). For tritium in drinking water, the EPA (2002) has established a maximum contaminant level of 20,000 pCi/L, which is equivalent to 4 millirems per year (mrem/yr) or 2.7×10^{-6} rad/d. Because the EPA's drinking water standard is significantly lower than the DOE's previously described dose rate criterion of ≤1 rad/d for aquatic organisms, the NRC staff concludes that even the most sensitive aquatic receptors, including listed species, would not be affected by tritium concentrations below 20,000 pCi/L.[1]

During operation, Turkey Point discharges liquid effluent containing tritium into the CCS. The site's NPDES permit (FDEP 2005) does not permit FPL to discharge to surface waters of the State. The FDEP (2018f) recently issued a draft renewed NPDES permit for Turkey Point. The draft permit, if issued, would continue to prohibit discharges to surface waters of the State. However, tritium may leave the CCS and enter nearby surface water bodies through one of two pathways: (1) as liquid through groundwater or (2) as gas through the air. Thus, for tritium associated with Turkey Point operation to enter Biscayne Bay, tritium molecules would either have to travel from the CCS as liquid water into the groundwater below the CCS (i.e., the Biscayne aquifer) and then through the aquifer's porous limestone bedrock and into the surface waters of Biscayne Bay, or tritium molecules would have to leave the CCS as water vapor and subsequently settle onto the bay's surface through rainfall or other forms of condensation, such as fog.

FPL monitors Biscayne Bay surface water at five stations (TPBBSW-3, 4, 5, 10, and 14) (as described in detail in Section 3.5.1.4, "Adjacent Surface Water Quality and Cooling Canal System Operation," of this SEIS). FPL collects surface water data, including tritium concentrations, from these stations on a quarterly or semi-annual basis. Observed tritium levels at these stations are extremely low and well below the EPA's 20,000 pCi/L standard. For instance, during the most recently available reporting period of June 1, 2017, through May 31, 2018, FPL (2018o) reported a maximum concentration of 18.5 pCi/L and an average concentration of 7.8 pCi/L at its Biscayne Bay monitoring stations. During the historical period of record (June 2010 through May 2017), FPL (2018o) reported a maximum concentration of 34.5 pCi/L and an average concentration of 11.7 pCi/L at its Biscayne Bay monitoring stations. Based on these values, an aquatic organism could potentially be exposed to a maximum concentration of 34.5 pCi/L, which is equivalent to 0.0069 mrem/yr or 1.9×10^{-8} rad/d. For the purposes of evaluating the potential effects of radiological contaminants on listed species, this value is so low as to be effectively zero. Accordingly, listed species in the action area would experience no effects from exposure to radiological contaminants resulting from continued operation of Turkey Point.

[1] In addition to the EPA's drinking water standard, the NRC regulates radiological releases, including tritium, through its regulations at 10 CFR Part 20 and Appendix I to 10 CFR Part 50.

Conclusion

In conclusion, potential impacts on federally listed species under the NMFS's jurisdiction associated with the proposed action could result from (1) interactions of sea turtles and smalltooth sawfish with barge vessels and (2) the potential for sea turtles and smalltooth sawfish to experience water quality impacts through the exchange of CCS water with other surface waters through a groundwater pathway. For the reasons set forth above, the NRC staff finds these potential impacts to be discountable or insignificant. Accordingly, the NRC staff concludes that the proposed subsequent license renewal of Turkey Point may affect, but is not likely to adversely affect, loggerhead, green, leatherback, hawksbill, and Kemp's ridley sea turtles and smalltooth sawfish.

Cumulative Effects

The ESA regulations at 50 CFR 402.12(f)(4) direct Federal agencies to consider cumulative effects as part of the proposed action effects analysis. Under the ESA, cumulative effects are defined as "those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation" (50 CFR 402.02, "Definitions"). Unlike the National Environmental Policy Act (NEPA) definition of cumulative impacts (see Section 4.16, "Cumulative Impacts"), cumulative effects under the ESA do not include past actions or other Federal actions requiring separate ESA Section 7 consultation. When formulating biological opinions under formal ESA Section 7 consultation, the FWS and the NMFS (1998) consider cumulative effects when determining the likelihood of jeopardy or adverse modification. Therefore, cumulative effects need only be considered under the ESA if listed species will be adversely affected by the proposed action and formal Section 7 consultation is necessary (FWS 2014b). Because the NRC staff concluded earlier in this section that the proposed subsequent license renewal is not likely to adversely affect sea turtles or smalltooth sawfish, consideration of cumulative effects for these species is not necessary. For those species under the FWS's jurisdiction, cumulative impacts are discussed, as appropriate, in the staff's biological assessment (NRC 2018n).

4.8.1.2 Essential Fish Habitat Protected Under the Magnuson–Stevens Act

Section 3.8, "Special Status Species and Habitat," describes seven federally managed species for which the South Atlantic Fishery Management Council and NMFS have designated Essential Fish Habitat (EFH) under the Magnuson–Stevens Fishery Conservation and Management Act of 1996, as amended (MSA), in Biscayne Bay: pink shrimp (*Farfantepenaeus duorarum*), white grunt (*Haemulon plumieri*), bluestriped grunt (*Haemulon sciurus*), mutton snapper (*Lutianus analis*), dog snapper (*Lutianus jocu*), gray snapper (*Lutjanus griseus*), and spiny lobster (*Panulirus argus*). In that section, the NRC staff concludes that while EFH occurs in Biscayne Bay, neither EFH nor the species themselves occur on the Turkey Point site.

The proposed Turkey Point subsequent license renewal would not result in any impacts to EFH. As described above in Section 4.8.1.1, "Federally Listed Species and Critical Habitats Protected Under the Endangered Species Act," the only potential activity that would affect aquatic resources outside of the Turkey Point site is vessel traffic associated with infrequent deliveries of large parts and equipment to the Turkey Point site and specifically associated with Units 3 and 4. However, such traffic would not impact any aquatic habitats (including prey) in any noticeable or measurable way and, thus, would also not affect EFH. The NRC staff also does not expect that federally managed species themselves or their prey would be directly affected by barge traffic because individuals could swim away to avoid vessels. Additionally, several of the federally managed species or their prey are bottom-dwelling species that do not typically occur in the top of the water column where they might encounter vessels. Biscayne Bay water quality is not likely to be affected by continued Turkey Point operations in any way that would be discernable on the aquatic ecology of Biscayne Bay for the reasons set forth in Section 4.8.1.1. The NRC staff, therefore, concludes that the proposed action would have no adverse effects on EFH. Accordingly, the NRC staff also finds that EFH consultation for the proposed action is not required.

4.8.1.3 Marine Sanctuary Resources Protected Under the National Marine Sanctuaries Act

Under Section 304(d) of the National Marine Sanctuaries Act (NMSA), Federal agencies must consult with the National Oceanic and Atmospheric Administration's (NOAA's) Office of National Marine Sanctuaries if a Federal action is likely to destroy, cause the loss of, or injure any sanctuary resources. Within Southern Florida, Congress has designated the Florida Keys National Marine Sanctuary to include 2,900 nautical mi^2 (5,370 nautical km^2) of waters surrounding the Florida Keys from south of Miami westward and encompassing the Dry Tortugas. This area includes Card Sound. Section 3.8.3, "Marine Sanctuary Resources Protected Under the National Marine Sanctuaries Act," of this SEIS describes the marine resources of the sanctuary and includes a figure showing the sanctuary's geographic boundaries.

The NRC staff has determined that the proposed Turkey Point subsequent license renewal would not affect the sanctuary resources of the Florida Keys National Marine Sanctuary for several reasons. First, currently available monitoring data do not indicate any discernable impact of the CCS on the ecology of surrounding marsh and mangrove areas, Biscayne Bay, Card Sound, or any other nearby surface waters to date. Second, FPL's continued implementation of its 2016 Consent Order with the Florida Department of Environmental Protection and 2015 Consent Agreement with the Miami-Dade County Department of Environmental Resources will ensure that any potential future impacts of the CCS will be mitigated such that constituents originating from the CCS will not discernably affect the ecology of nearby surface waters over the course of the proposed subsequent license renewal term.

Groundwater monitoring results indicate that water from the CCS has migrated via the groundwater pathway through the deeper interval of the Biscayne aquifer and to the east beneath Biscayne Bay and Card Sound. However, CCS-sourced constituents, which consist of elevated chloride, tritium, and possibly ammonia, have had no effect on surface water quality in Biscayne Bay and Card Sound. At no location outside the boundary of the Turkey Point site do tritium levels in groundwater approach the U.S. Environmental Protection Agency and State primary drinking water standard for tritium of 20,000 pCi/L (40 CFR 141.66). The NRC staff concludes that the proposed action is not likely to destroy, cause the loss of, or injure any sanctuary resources. Accordingly, the NRC staff also finds that consultation under the National Marine Sanctuaries Act for the proposed action is not required.

4.8.2 No-Action Alternative

Under the no-action alternative, the NRC would not issue subsequent renewed licenses, and Turkey Point would shut down on or before the expiration of the current renewed licenses. The ESA action area for the no-action alternative would most likely be the same or similar to the action area described in this section for the proposed subsequent license renewal. However, a determination of effects would depend on the specific shutdown activities that would be included in the proposed action as well as the listed species and critical habitats present when the no-action alternative is implemented.

The CCS would continue to operate under the no-action alternative regardless of the proposed Turkey Point subsequent license renewal because it supports retired fossil fuel Units 1 and 2. FPL plans to continue to use water from the CCS to support the operation of these units in synchronous condenser mode over the course of the proposed subsequent license renewal period, as described in Section 3.1.3, "Cooling and Auxiliary Water Systems." Additionally, fossil fuel Unit 5 would remain in operation and would continue to discharge blowdown to the CCS. CCS conditions could change under the no-action alternative because less heat would be discharged to the system. This would potentially reduce evaporation resulting in less saline conditions that would be more favorable to ESA-listed species, such as the American crocodile. On the other hand, CCS flow would likely decrease because Turkey Point Units 3 and 4 would withdraw substantially reduced quantities of water during the shutdown period, and eventually Turkey Point 3 and 4 would cease to circulate water through the CCS entirely. This could lead to stagnant conditions, which could lower habitat quality and promote algae growth, both of which could affect ESA-listed species and habitats, such as the American crocodile and its critical habitat. Regardless, FPL would continue CCS restoration activities, as previously described in the discussion of the no-action alternative's impacts on water resources in Section 4.5.2 of this SEIS. The State of Florida requires these activities under FPL's Nutrient Management Plan, which is independent of subsequent license renewal. The CCS would likely continue to provide habitat for foraging and breeding, and restoration activities would benefit species that rely upon the CCS as a source of prey. For instance, CCS berms would continue to provide potential nesting habitat for American crocodiles, and the CCS canals would continue to serve as refuge and a source of prey for this species.

FPL currently implements a crocodile management plan to help improve breeding and nesting habitat and protect American crocodiles on the Turkey Point site. Many portions of this plan are voluntary and not required by any Federal, State, or local permit. During shutdown, FPL would decide whether to stop or continue implementing the crocodile management plan.

Shutdown of the plant with the currently existing cooling system would likely not affect the marine environments of Biscayne Bay, Card Sound, or the Atlantic Ocean. As such, there would likely be no effects on federally listed species or critical habitats under the NMFS's jurisdiction, on EFH, or on sanctuary resources of the Florida Keys National Marine Sanctuary. If necessary, any reinitiated consultation with the FWS pursuant to Section 7 of the ESA would determine effects on the American crocodile, its critical habitat, and other terrestrial and freshwater listed species based on circumstances that might exist at that time. However, a specific determination of effects and consultation requirements at such time would depend on the nature of shutdown and decommissioning activities, the action area associated with those activities, and the listed species, critical habitats, and EFH present when the no-action alternative is implemented.

4.8.3 Replacement Power Alternatives: Common Impacts

All of the replacement power alternatives would entail construction and operation of a new energy-generating facility on the existing Turkey Point site; certain of these alternatives would also entail offsite construction, in part, which is addressed for each of those alternatives below. The ESA action area, EFH, and marine sanctuary resources potentially affected by any new plant would be similar to the subsequent license renewal action area because the replacement power generating alternatives would generally be sited on the existing site. However, specifically defining the action area would depend on exact plant siting, planned construction activities, temporary and permanent structure locations, and timeline of the alternative. Similarly, the listed species, critical habitats, EFH, and marine sanctuary resources potentially affected by a particular alternative would depend on the boundaries of that alternative's effects and the species and habitats protected at the time the alternative is implemented. For instance, if Turkey Point continues to operate until the end of the current renewed license terms (2032 for Unit 3 and 2033 for Unit 4) and the replacement power alternative is implemented at that time, the FWS and NMFS may have listed new species, delisted currently listed species whose populations may have recovered, or revised EFH designations. These listing and designation activities would change the potential for the various alternatives to impact special status species and habitats. Additionally, requirements for ESA Section 7 consultation with the FWS and NMFS, EFH consultation with the NMFS, and possible NMSA consultation with NOAA, would depend on whether Federal permits or authorizations are required in order to implement each particular alternative.

Sections 4.6.3 and 4.7.3 (both titled "Replacement Power Alternatives: Common Impacts") describe the types of impacts that terrestrial and aquatic resources would experience under each alternative. Impacts on special status species and habitats would likely be similar in type. However, the magnitude and significance of such impacts could be larger because special status species and habitats are rare and more sensitive to environmental stressors.

As described above under the no-action alternative, the CCS would continue to operate under the no-action alternative regardless of the proposed Turkey Point license renewal because it supports retired fossil fuel Units 1 and 2. FPL plans to continue to use water from the CCS to support the operation of these units in synchronous condenser mode over the course of the proposed subsequent license renewal period, as described in Section 3.1.3, "Cooling and Auxiliary Water Systems." Additionally, fossil fuel Unit 5 would remain in operation and would continue to discharge blowdown to the CCS. CCS conditions could change with implementation of one of the replacement power alternatives because less heat would be discharged to the system. This would potentially reduce evaporation resulting in less saline conditions that would be more favorable to ESA-listed species, such as the American crocodile. On the other hand, CCS flow would likely decrease because Turkey Point Units 3 and 4 would withdraw substantially reduced quantities of water during the shutdown period, and eventually Turkey Point Units 3 and 4 would cease to circulate water through the CCS entirely. This could lead to stagnant conditions, which could lower habitat quality and promote algae growth, both of which could affect ESA-listed species and habitats, such as the American crocodile and its critical habitat. Regardless, FPL would continue CCS restoration activities, as previously described in the discussion of the common impacts of replacement power alternatives on water resources in Section 4.5.3 of this SEIS. The State of Florida requires these activities under FPL's Nutrient Management Plan, which is independent of subsequent license renewal. The CCS would likely continue to provide habitat for foraging and breeding, and restoration activities would benefit species that rely upon the CCS as a source of prey. For instance, CCS berms would continue to provide potential nesting habitat for American crocodiles, and the CCS canals would continue to serve as refuge and a source of prey for this species.

FPL currently implements a crocodile management plan to help improve breeding and nesting habitat and protect American crocodiles on the Turkey Point site. Many portions of this plan are voluntary and not required by any Federal, State, or local permit. During shutdown, FPL would decide whether to stop or continue implementing the crocodile management plan.

4.8.3.1 New Nuclear Alternative

The NRC staff did not identify any impacts to special status species and habitats for the new nuclear alternative beyond those discussed in the impacts common to all replacement power alternatives. As described above, the CCS would continue to operate regardless of whether a replacement power alternative is implemented, and the impacts discussed previously that would be associated with continued operation of the CCS would apply to this alternative. Because the NRC would remain the licensing agency under this alternative, the ESA, MSA, and NMSA could require the NRC to consult with the FWS, NMFS, or NOAA, as applicable, prior to issuing a license for the construction and operation of the new plant in order to consider whether the plant would affect any federally listed species, adversely modify or destroy designated critical habitat, result in adverse effects on EFH, if present, or injure sanctuary resources of the Florida Keys National Marine Sanctuary. If the new power plant required a Clean Water Act, Section 404 permit, the USACE may be a cooperating agency for the ESA consultation. Ultimately, the magnitude and significance of adverse impacts on special status species and habitats would depend on the site location and layout, plant design, plant operations, and the special status species and habitats present in the area when the alternative is implemented.

4.8.3.2 Natural Gas Combined-Cycle Alternative

The NRC staff did not identify any impacts to special status species and habitats for the natural gas alternative beyond those discussed in the impacts common to all replacement power alternatives. Unlike Turkey Point subsequent license renewal or the licensing of a new nuclear alternative, the NRC does not license natural gas facilities; therefore, the NRC would not be responsible for initiating ESA Section 7 consultation, EFH consultation, or NMSA consultation if special status species or habitats might be adversely affected under this alternative. Other Federal agencies could be responsible for addressing impacts on special status species and habitats depending on the specific permits or licenses that the new plant would require. For instance, if the new power plant required a Clean Water Act, Section 404 permit, the ESA would require the USACE to consider impacts on federally listed species and EFH. If no Federal permits were required, the companies or entities implementing this alternative would be responsible for ensuring that their actions do not jeopardize the continued existence of listed species because the ESA Section 9 take prohibitions apply to both Federal and non-Federal entities. The MSA only requires EFH consultation for Federal actions. Similarly, NMSA consultation only applies to Federal agencies. Therefore, these consultations would be required if a Federal agency, such as the USACE, is involved in the permitting or authorization of this alternative and adverse effects are possible. As described above, the CCS would continue to operate regardless of whether a replacement power alternative is implemented, and the impacts discussed previously that would be associated with continued operation of the CCS would apply to this alternative. Ultimately, the magnitude and significance of adverse impacts on special status species and habitats would depend on the site location and layout, plant design, plant operations, and the special status species and habitats present in the area when the alternative is implemented.

4.8.3.3 Combination Alternative (Natural Gas Combined-Cycle Alternative and Solar Photovoltaic Generation)

The NRC staff did not identify any impacts to special status species and habitats for the combination alternative beyond those discussed in the impacts common to all replacement power alternatives and in the natural gas-only alternative. As described above, the CCS would continue to operate regardless of whether a replacement power alternative is implemented, and the impacts discussed previously that would be associated with continued operation of the CCS would apply to this alternative. The magnitude and significance of adverse impacts on special status species and habitats resulting from this alternative would depend on the site location and layout, plant design, plant operations, and the special status species and habitats present in the area when the alternative is implemented.

4.8.3.4 Cooling Water System Alternative

The NRC staff did not identify any impacts to special status species and habitats for the cooling water system alternative beyond those discussed in the impacts common to all replacement power alternatives. As described above, the CCS would continue to operate regardless of whether cooling towers are constructed to support Turkey Point Units 3 and 4, and the impacts discussed previously that would be associated with continued operation of the CCS would apply to this alternative. To the extent that license amendments would be necessary to authorize cooling towers to dissipate excess heat during plant operation, the NRC would be the licensing agency under this alternative and the ESA, MSA, and/or NMSA would require the NRC to consult with the FWS, NMFS, or NOAA, as applicable, during the staff's review of that alternative. If the cooling water system alternative required a Clean Water Act, Section 404 permit, the USACE could be involved in these consultations. The consultations would determine whether the construction and operation of cooling towers would affect any federally listed species; adversely modify or destroy designated critical habitat; result in adverse effects on EFH, if present; or destroy, cause the loss of, or injure sanctuary resources of the Florida Keys National Marine Sanctuary. Because much of the Turkey Point site is designated as critical habitat for the American crocodile, land clearing and other construction activities could result in adverse impacts to this species and its critical habitat. The indigo snake, which also inhabits the site, could also experience adverse impacts from construction. Other federally listed species could also be affected. Ultimately, the magnitude and significance of adverse impacts on special status species and habitats would depend on the location and layout of the cooling towers, the design of the cooling towers, operational parameters, and the special status species and habitats present in the area when the alternative is implemented. As stated above, the NRC would consult with the FWS and NMFS, as applicable, during the staff's review of the license amendments associated with this alternative to determine the level of impact to ESA-listed species and habitats and to address any identified adverse effects.

4.9 <u>Historic and Cultural Resources</u>

This section describes the potential historic and cultural resources impacts of the proposed action (subsequent license renewal) and alternatives to the proposed action.

4.9.1 Proposed Action

Table 4-2 identifies one site-specific (Category 2) issue related to historic and cultural resources applicable to Turkey Point during the subsequent license renewal term. This issue is analyzed below.

4.9.1.1 Category 2 Issue Related to Historic and Cultural Resources: Historic and Cultural Resources

The National Historic Preservation Act of 1966, as amended (54 U.S.C. 300101 et seq.) (NHPA), requires Federal agencies to consider the effects of their undertakings on historic properties. Issuing a subsequent renewed license to a nuclear power plant is an undertaking that could potentially affect historic properties. Historic properties are defined as resources included on, or eligible for inclusion on, the National Register of Historic Places (NRHP). The criteria for eligibility are listed in Title 36, "Parks, Forests, and Public Property," of the *Code of Federal Regulations* (36 CFR) Section 60.4, "Criteria for Evaluation," and include (a) association with significant events in history, (b) association with the lives of persons significant in the past, (c) embodiment of distinctive characteristics of a type, period, or method of construction, or (d) sites or places that have yielded, or are likely to yield, important information.

The historic preservation review process (NHPA Section 106) is outlined in regulations issued by the Advisory Council on Historic Preservation (ACHP) in 36 CFR Part 800, "Protection of Historic Properties." In accordance with NHPA provisions, the NRC establishes the undertaking (subsequent license renewal), identifies the appropriate State or Tribal historic preservation officer, and initiates consultation with the appropriate officer. The NRC is required to make a reasonable effort to identify historic properties included in, or eligible for inclusion in, the NRHP in the area of potential effect (APE). The APE for a subsequent license renewal action includes the power plant site, the transmission lines up to the first substation, and immediate environs that may be affected by the subsequent license renewal decision and land-disturbing activities associated with continued reactor operations during the subsequent license renewal term. In addition, the NRC is required to notify the State historic preservation officer if historic properties would not be affected by subsequent license renewal or if no historic properties are present. In Florida, State historic preservation officer responsibilities lie with the Florida Division of Historical Resources.

4.9.1.2 Consultation

In accordance with 36 CFR 800.8, "Coordination with the National Environmental Policy Act," on May 24, 2018, the NRC initiated consultation with the Advisory Council on Historic Preservation, the Florida State historic preservation officer, and the Miami-Dade County Office of Historic Preservation (NRC 2018j). Also, on May 24, 2018, the NRC initiated consultation with the following federally recognized tribes (NRC 2018j) (see Appendix C, "Consultation Correspondence"):

- Miccosukee Tribe of Indians of Florida
- Muscogee (Creek) Nation
- Poarch Band of Creek Indians
- Seminole Tribe of Florida
- Seminole Nation of Oklahoma

In these letters, the NRC provided information about the proposed action, provided its definition of the APE, and indicated that the NHPA review would be integrated with the NEPA process, in accordance with 36 CFR 800.8(c), "Use of the NEPA Process for Section 106 Purposes." The NRC invited participation in the identification and possible decisions concerning historic properties and also invited participation in the scoping process. The Seminole Tribe of Florida stated in correspondence to the NRC that they "have no comments regarding license renewal at this time" (STOF 2018). The Florida State Department, Division of Historic Resources stated in correspondence that since the proposed action will not involve ground disturbance it is "unlikely to affect historic properties" (DHR 2018). The Seminole Nation of Oklahoma requested consultation meetings with the NRC (SNO 2018). The NRC held a teleconference with the Seminole Nation of Oklahoma Tribal historic preservation officer on July 2, 2018 (NRC 2018k). Upon learning that the proposed action pertains to the license renewal of the existing Units 3 and 4 and that the plant uses a system of cooling canals rather than discharging into Biscayne

Bay, the Tribal historic preservation officer did not express concerns regarding the subsequent license renewal of Turkey Point (NRC 2018k). In addition, the Seminole Nation of Oklahoma Tribal historic preservation officer requested a list of flora present at the Turkey Point site; in response, the NRC staff provided a 2017 ecological monitoring survey of the Turkey Point site and vicinity to the Tribe on July 9, 2018 (NRC 2018k). FPL received similar responses from the Florida State historic preservation office, Seminole Nation of Oklahoma, and the Seminole Tribe of Florida regarding the proposed action (FPL 2018h).

Following issuance of the DSEIS, the NRC received comments from the Poarch Band of Creek Indians; the Poarch Band of Creek Indians concurred with the NRC's determination (PBCI 2019). In correspondence, the Florida State Department, Division of Historic Resources concurred that license renewal will not adversely affect known historic properties (DHR 2019).

4.9.1.3 Findings

As described in Section 3.9, "Historic and Cultural Resources," cultural resource surveys conducted within the 9,460-ac (3,828-ha) Turkey Point site did not identify archeological sites and concluded that the site has a low archeological potential. However, as discussed in Section 3.9, during the NRC staff's environmental site audit, NRC staff became aware of three wooden buildings that were part of a Boy Scouts of America camp and a cottage (known as the Ranger House/McGregor Smith Cottage) of potential historic significance on the Turkey Point site that are over 50 years old (FPL 2018h, NRC 2018c). The Boy Scouts structures and the Ranger House/McGregor Smith Cottage have not been evaluated for eligibility for listing in the NRHP. Given the age of the Ranger House/McGregor Smith Cottage (50 years old) and known association with McGregor Smith Cottage, the NRC believes that the cottage is potentially eligible for listing in the NRHP under Criterion b (association with the lives of persons significant in the past). McGregor Smith was known for his involvement with the Boy Scouts of America and environmental conservation; it is possible that onsite Boy Scouts structures were associated with McGregor Smith (FPL 2018m). Similarly, as a result of McGregor Smith's known involvement with the Boy Scouts, the Boy Scouts structures on the Turkey Point site may potentially be eligible for listing in the NRHP under Criterion b.

Within a 6-mi (9.7-km) radius of the site are two properties determined eligible for listing in the NRHP: K-9 cemetery (approximately 5.9 mi (9.5 km) from Turkey Point) and a canal bridge (approximately 3.6 mi (5.8 km) from Turkey Point). During the environmental site audit, the NRC staff observed that Turkey Point is not visible from these two sites due to tree buffers and distance (NRC 2018c).

FPL did not identify subsequent license renewal-related ground-disturbing activities (FPL 2018f; FPL 2018h). Plant operations and maintenance activities necessary to support subsequent license renewal would likely be limited to previously disturbed areas of the site (FPL 2018f). In the event that ground-disturbing activities are required as a result of plant operations and maintenance activities, FPL has administrative controls in place on how to handle unanticipated historical and cultural finds related to potential ground-disturbing activities. If historic and cultural resources are discovered within the project site, FPL will notify Florida's Division of Historical Resources and the FDEP, Southeast District (FPL 2018f). Additionally, FPL provides training sessions for staff that are involved in potential future ground-disturbing activities; the environmental training sessions are intended to familiarize FPL staff with common artifact types and actions to be taken if cultural resources are identified (FPL 2018h).

Based on (1) Tribal input, (2) no new ground disturbance, (3) FPL's administrative controls, and (4) State historic preservation officer input, the NRC staff concludes that subsequent license renewal for Turkey Point Units 3 and 4 would not adversely affect any known historic properties or historic and cultural resources.

4.9.2 No-Action Alternative

Under the no-action alternative, the NRC would not issue subsequent renewed licenses, and FPL would terminate reactor operations on or before the expiration of the current renewed licenses. As a result of facility shutdown, land-disturbing activities or dismantlement are not anticipated as these would be conducted during decommissioning. Therefore, facility shutdown would have no immediate effect on historic properties or historic and cultural resources.

4.9.3 Replacement Power Alternatives: Common Impacts

If construction and operation of replacement power alternatives require a Federal undertaking (e.g., license, permit), the Federal agency would need to make a reasonable effort to identify historic properties within the area of potential effects and consider the effects of their undertakings on historic properties, in accordance with Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended (54 U.S.C. 300101 et seq.). Historic and cultural resources identified would need to be recorded and evaluated for eligibility for listing on the NRHP. If historic properties are present and could be affected by the undertaking, adverse effects would be assessed, determined, and resolved in consultation with the State historic preservation officer and any Indian tribe that attaches religious and cultural significance to identified historic properties through the Section 106 process.

Construction

Impacts to historic and cultural resources from the construction of replacement power alternatives are primarily related to ground disturbance (land clearing, excavations, etc.). For the new nuclear alternative, natural gas combined-cycle alternative, and the natural gas combined-cycle portion and one installation of the solar photovoltaic portion of the combination alternative, this environmental review assumes that the new facilities would be built on the Turkey Point site. For the solar portion of the combination alternative, this environmental review assumes that three of the new facilities would occur at other sites in Miami-Dade County and/or Broward County. As discussed in Section 3.9.2, "Historic and Cultural Resources," of this SEIS, while a comprehensive cultural resource survey of the entire 9,460-ac (3,828-ha) Turkey Point site has not been conducted, cultural resource surveys that have been completed have concluded that the Turkey Point site has a low archeological potential. Land areas not previously surveyed (onsite and offsite) that are affected by the construction of power alternatives would need to be surveyed to identify and record historic and cultural resources.

Operation

The potential for impacts on historic and cultural resources from the operation of replacement power alternatives would be related to maintenance activities at the site as well as visual impacts that would vary with plant heights and associated exhaust stack or cooling towers. The replacement power alternatives located at the Turkey Point site would be in an industrialized area where tall structures already exist and visible plumes from the Turkey Point Unit 5 cooling towers occur.

4.9.3.1 New Nuclear Alternative

Impacts on historic and cultural resources from the construction and operation of a new nuclear alternative would include those common to all replacement power alternatives. The new nuclear alternative would require an estimated 360 ac (240 ha) of land on the Turkey Point site. Within a 6-mi (9.7-km) radius of the site are two offsite properties (at distances of 3.6 mi (5.8 km) and 5.9 mi (9.5 km) from the Turkey Point site) determined to be eligible for listing in the NRHP. The tallest structures would be the containment buildings at approximately 230 feet (70 m). A visible plume would occur from the draft cooling towers, particularly during winter months, which could have a median plume length of 820 feet (250 m) (NRC 2016a). Tall structures and cooling tower plumes that currently exist on the Turkey Point site are not visible from the two NRHP-eligible sites. Given the presence of tree buffers and distance, the NRC staff does not anticipate that the new structures and plumes as a result of the new nuclear alternative would be visible from these offsite NRHP-eligible properties. As discussed in Section 4.9.1.3 of this SEIS, there are historic structures on the Turkey Point site that are potentially eligible for listing on the NRHP. Construction of the new nuclear alternative on or near these structures, however, could be avoided. Depending on where the new nuclear alternative is located within the FPL site, construction and operation of this alternative could introduce additional containment buildings, stacks, and facility support structures and affect the viewshed of these historic structures. However, the Turkey Point site is an industrialized area restricted to the public where tall structures and plumes already exist. Therefore, construction and operation of the new nuclear alternative would be compatible with the current site and not out of character with the current setting.

Given that the Turkey Point site has a low archeological potential, that current site infrastructure use would be maximized, and that avoidance of significant historic resources would be possible, the NRC staff concludes that construction of the new nuclear alternative on the Turkey Point site would not adversely affect historic and cultural resources.

4.9.3.2 Natural Gas Combined-Cycle Alternative

Impacts on historic and cultural resources from the construction and operation of a new natural gas alternative would include those common to all replacement power alternatives. The natural gas facility would require an estimated 75 ac (30 ha) for the power block and support facilities and an additional 1,200 ac (490 ha) for a natural gas pipeline. Construction of the natural gas pipeline would use existing utility corridors to the extent possible. Within a 6-mi (9.7-km) radius of the site are two properties (approximately 3.6 mi (5.8 km) and 5.9 mi (9.5 km) from the Turkey Point site) determined to be eligible for listing in the NRHP. The tallest natural gas alternative structure would be the plant stacks at approximately 150-feet tall (46-m). The current Turkey Point containment structures are not visible from the two NRHP-eligible sites. Because the natural gas plant stacks would be shorter than the current Turkey Point containment structures, the NRC staff does not anticipate that the natural gas plant stacks would be visible from the NRHP-eligible sites. A visible plume would occur from the draft cooling towers, particularly during winter months, which could have a median plume length of 820 feet (250 m) (NRC 2016a). However, the NRC staff does not anticipate that the plume would be visible from these offsite NRHP-eligible sites given the presence of tree buffers and distance.

As discussed in Section 4.9.1.3 of this SEIS, there are historic structures on the Turkey Point site that are potentially eligible for listing in the NRHP. Construction of the natural gas alternative on or near these structures, however, could be avoided. Depending on where the natural gas alternative is located within the FPL site, construction and operation of this alternative would introduce additional containment buildings, stacks, and facility support structures and affect the viewshed of these historic structures. However, the Turkey Point site is an industrialized area, restricted to the public, where tall structures and plumes already exist. Therefore, construction and operation of the natural gas alternative would be compatible with the current site and not out of character with the current setting.

Given that the Turkey Point site has a low archeological potential and that existing infrastructure use would be maximized, including the preferential use of previously disturbed land for the pipeline, the avoidance of significant historic resources would be possible. Therefore, the NRC staff concludes that construction and operation of the natural gas alternative on the Turkey Point site would not adversely affect historic and cultural resources.

4.9.3.3 Combination Alternative

Impacts on historic and cultural resources from the construction and operation of the natural gas components of the combination alternative would be the same as the natural gas-only alternative given that land requirement, location, and facility height structures would be the same. Therefore, the NRC staff concludes that construction and operation of the natural gas portion of the combination alternative on the Turkey Point site would not adversely affect historic and cultural resources. As stated in Section 2.2.2.3 of this SEIS, the NRC staff assumes that the solar portion that would be located on the Turkey Point site would maximize use of the existing infrastructure, would have a low visual profile, and would be located on a site that has a low archeological potential. Construction and operation of the solar alternative on or near historic and cultural resources could be avoided. Therefore, construction and operation of the solar component on the Turkey Point site would not adversely affect historic and cultural resources.

Impacts on historic and cultural resources from the construction and operation of the solar portion of the combination alternative would include those common to all replacement power alternatives. The solar portion of the combination alternative would require an estimated 470 ac (190 ha) for each of the four solar facilities. The impacts from the construction and operation of the solar component on historic and cultural resources would vary, depending on where solar facilities are constructed. The three offsite solar facilities would be installed in Miami-Dade and/or Broward Counties, but the exact locations are unknown. Depending on the site and historic and cultural resources present, construction and operation of the solar facilities could alter these resources within the area of potential effect. Areas with the greatest cultural sensitivity could be avoided or effectively managed. Therefore, for these three sites, the historic and cultural resource impact could range from no adverse effect to adverse effect.

4.9.4 Cooling Water System Alternative

If construction and operation of the cooling water system alternative were to require NRC licensing actions (e.g., a license amendment), the NRC would need to comply with Section 106 of NHPA consultation requirements. The Section 106 process would be initiated after submission of an application or request from FPL.

Land areas needed to support construction of the mechanical draft cooling towers would need to be surveyed for historic and archeological resources. Any resources found during these surveys would need to be evaluated for their eligibility for listing on the NRHP, and any adverse effects would need to be mitigated. Constructing the cooling towers on previously disturbed land could reduce the potential impact to historic and archaeological resources. As discussed in Section 3.9.2 of this SEIS, while a comprehensive cultural resource survey of the entire 9,460-ac (3,828-ha) Turkey Point site has not been conducted, cultural resource surveys that have been completed have concluded that the Turkey Point site has a low archeological potential. Within a 6-mi (9.7-km) radius of the site there are two offsite properties (approximately 3.6 mi (5.8 km) and 5.9 mi (9.5 km) from the Turkey Point site) which were determined to be eligible for listing in the NRHP. The cooling towers would be approximately 70 feet (20 m) in height and plumes could be visible during the winter months with a median length of 820 feet (250 m) (NRC 2016a). However, the plume is not anticipated to be visible from these offsite NRHP-eligible sites given the presence of tree buffers and distance.

As discussed in Section 4.9.1.3 of this SEIS, there are historic structures on the Turkey Point site that are potentially eligible for listing in the NRHP. Construction of the cooling towers on or near these structures could be avoided. Depending on where the cooling towers are located within the FPL site, construction and operation of this alternative would introduce additional cooling towers and visible plumes and would affect the viewshed of these historic structures. However, the Turkey Point site is an industrialized area, restricted to the public, where tall structures and visible plumes already exist. Therefore, construction and operation of the cooling towers would be compatible with the current site and not out of character with the current setting.

The Turkey Point site has a low archeological potential and avoidance of construction and operations impacts of the cooling water system alternative to significant historic resources would be possible. The plume from the Turkey Point cooling towers is not anticipated to be visible from offsite historic properties within a 6-mi radius of Turkey Point. Therefore, the NRC staff concludes that construction and operation of the cooling water system alternative on the Turkey Point site would not adversely affect historic and cultural resources.

4.10 Socioeconomics

This section describes the potential socioeconomic impacts of the proposed action (subsequent license renewal) and alternatives to the proposed action.

4.10.1 Proposed Action

According to the GEIS (NRC 2013a), the impacts of license renewal on socioeconomic issues would be SMALL. The NRC staff identified no new or significant information for these issues. Socioeconomic effects of ongoing reactor operations at Turkey Point have become well established as regional socioeconomic conditions have adjusted to the presence of the nuclear power plant. Any changes in employment and tax revenue caused by subsequent license renewal and any associated refurbishment activities could have a direct and indirect impact on community services and housing demand, as well as traffic volumes in the communities around the nuclear power plant. FPL indicated in its environmental report that it has no plans to add non-outage workers during the subsequent license renewal term, does not anticipate changes in tax payments during the subsequent license renewal term, and will not conduct refurbishment activities. Consequently, people living in the vicinity of Turkey Point and in Miami-Dade County are not likely to experience any changes in socioeconomic conditions during the subsequent license renewal term beyond what is currently being experienced under the current renewed licenses.

As identified in Table 4-1 of this SEIS, the socioeconomic impacts of continued reactor operations during the subsequent license renewal term would be SMALL. Table 4-2 of this SEIS does not identify any site-specific (Category 2) socioeconomic issues for Turkey Point.

4.10.2 No-Action Alternative

4.10.2.1 Socioeconomics

Under the no-action alternative, the NRC would not issue subsequent renewed licenses and FPL would shut down Turkey Point on or before the expiration of the current renewed licenses. Termination of nuclear power plant operations would result in cessation of electrical power production and a loss of jobs, income, and tax revenues. Socioeconomic impacts from the termination of reactor operations would be concentrated in Miami-Dade County since the majority of Turkey Point Units 3 and 4 workers reside in this county. Employment and income from the buying and selling of goods and services needed to operate and maintain the nuclear power plant would also be reduced.

As jobs are eliminated, some, but not all, of the total 1,046 FPL workers (permanent and contractors) could begin to leave the region. If FPL workers and their families move out of the region, increased housing vacancies and decreased demand could cause housing prices to fall. However, the FPL workforce that resides in Miami-Dade County (approximately 85 percent of the total Turkey Point permanent workforce) represents only approximately 0.05 percent of Miami-Dade County's 2016 civilian labor force (see Section 3.10.2.1, "Regional Employment and Income"). The remaining FPL workers similarly comprise a very small percentage (less than 0.1 percent) of the civilian labor force in other nearby counties. Therefore, the migration of these workers out of those nearby counties would not have a noticeable socioeconomic impact in those counties.

The loss of tax revenue could result in the reduction or elimination of some public and educational services. However, as noted in Section 3.10.5, "Tax Revenues," FPL property tax payments to Miami-Dade County and Miami-Dade County Public School District as a result of Turkey Point Units 3 and 4 operations represent less than 1 percent of Miami-Dade County total revenues and Miami-Dade County Public School District total revenues. Because Turkey Point is located in a large metropolitan area, socioeconomic impacts from not subsequently renewing the Units 3 and 4 operating licenses and terminating reactor operations would be SMALL.

4.10.2.2 Transportation

Traffic volume as a result of commuting workers and truck deliveries on roads in the vicinity of Turkey Point Units 3 and 4 would be reduced after plant shutdown. The reduction in traffic would be associated with the loss of jobs. Similarly, truck deliveries to Turkey Point would be reduced. Therefore, traffic-related transportation impacts would be SMALL as a result of the shutdown of Turkey Point Units 3 and 4.

4.10.3 Replacement Power Alternatives: Common Impacts

The following provides a discussion of the common socioeconomic and transportation impacts during construction and operation of replacement power generating facilities.

4.10.3.1 Socioeconomics

Socioeconomic impacts are defined in terms of changes in the social and economic conditions of a region. For example, the creation of jobs and the purchase of goods and services during the construction and operation of a replacement power plant could affect regional employment, income, and tax revenue. For each alternative, two types of jobs would be created: (1) construction jobs, which are transient, short in duration, and less likely to have a long-term socioeconomic impact, and (2) operations jobs, which have the greater potential for permanent, long-term socioeconomic impacts. The socioeconomic region of influence is Miami-Dade County for the new nuclear alternative and natural gas combined-cycle alternative. The socioeconomic region of influence for the combination alternative would be Miami-Dade and Broward counties.

<u>Construction</u>

The relative economic effect of an influx of workers on the local economy and tax revenue would vary and depend on the size of the workforce and construction completion time. The greatest impact would occur in the communities where the majority of construction workers would reside and spend their incomes. While some construction workers would be local, additional workers may be required from outside the immediate area depending on the local availability of appropriate trades and occupational groups. The region of influence could experience a short-term economic boom during construction from increased tax revenue, income generated by expenditures for goods and services, and the increased demand for temporary (rental) housing. After construction, the region of influence would likely experience a return to preconstruction economic conditions.

<u>Operation</u>

Prior to the commencement of startup and operations, local communities could see an influx of operations workers and their families resulting in an increased demand for permanent housing and public services. These communities would also experience the economic benefits from increased income and tax revenue generated by the purchase of goods and services needed to operate a new replacement power plant. Consequently, power plant operations would have a greater potential for effecting permanent, long-term socioeconomic impacts on the region.

4.10.3.2 Transportation

Transportation impacts are defined in terms of changes in level of service conditions on local roads in the region. Additional vehicles on local roadways during construction and operations could lead to traffic congestion, level of service impacts, and delays at intersections.

<u>Construction</u>

Transportation impacts during the construction of a replacement power plant would consist of commuting workers and truck deliveries of equipment and material to the construction site. Workers would arrive via site access roads, and the volume of traffic would increase during shift changes. In addition, trucks would transport equipment and material to the construction site, thus increasing the amount of traffic on local roads. The increase in traffic volumes could result in levels of service impacts and delays at intersections during certain hours of the day. In some instances, construction material could also be delivered by rail or barge.

Operation

Traffic-related transportation impacts would be greatly reduced after construction has been completed. Transportation impacts would include daily commuting by the operations workforce and deliveries of material, and the removal of commercial waste material by truck. Increased commuter traffic would occur during shift changes and deliveries of materials and equipment to the power plant.

4.10.4 New Nuclear Alternative

Socioeconomics

Construction of a new nuclear alternative would require a large workforce, approximately a peak at 3,900 workers. However, peak workforce construction jobs would represent approximately 0.3 percent of employment in Miami-Dade County. Tax revenue increases in the form of sales taxes and property taxes in the region would occur. However, because of the large tax revenue of Miami-Dade County (see Section 3.10.5), the impact on tax revenues during construction, while beneficial, would be relatively minimal. For instance, the NRC staff concluded that the taxes on construction expenses for Turkey Point Units 6 and 7 (estimated between $12.8 and $18.7 billion over a 12-year period) corresponded to approximately seven-tenths of 1 percent of Miami-Dade County sales and use tax revenues and 0.5 percent of the State of Florida's corporate income and excise tax revenues (NRC 2016a). As presented in Section 3.10.3.1, "Transient Population," and 3.10.4.1, "Housing," Miami-Dade County has available vacant rental units and housing to support a 3,900 peak construction workforce. Increases in property tax revenue are not anticipated during construction since property taxes due to the new nuclear units would not occur until after construction is completed (NRC 2016a). As a result of the construction workforce, service or retail-related jobs would be indirectly created (NRC 2016a). The NRC staff estimated that peak construction annual wage earnings of a workforce of 3,950 for Turkey Point Units 6 and 7 and indirect jobs would be less than eight-tenths of 1 percent of total annual wage earnings in Miami-Dade County (NRC 2016a). The construction of a new nuclear power plant would create a large number of jobs (directly and indirectly) and the socioeconomic impacts would be beneficial. The large workforce and jobs would be noticeable to the local communities in and near Homestead, FL. Therefore, the socioeconomic impacts from construction of a new nuclear alternative are SMALL to MODERATE.

Approximately 800 workers would be required during nuclear power plant operations, which would represent approximately 0.05 percent of the jobs in Miami-Dade County. Salary earnings of the workforce would be introduced into the Miami-Dade County economy, but they would not be noticeable. For instance, the NRC staff estimated that annual earnings of 806 operation workers for Turkey Point Units 6 and 7 would be a tenth of one percent of total wage earnings in Miami-Dade County (NRC 2016a). Tax revenues would increase as a result of operations of the new nuclear alternative. However, revenue generated by sales taxes and property taxes from operations of a new nuclear alternative would be minor. For instance, the NRC staff concluded that sales from operation of the proposed Turkey Point Units 6 and 7 would generate up to $2 million in sales tax and $50.4 million in property taxes. When compared to Miami-Dade County tax revenues (see Section 3.10.5, "Tax Revenues"), this is a small percentage. Furthermore, the number of operational and outage workers for a new nuclear alternative, property tax revenue, sales tax revenue, and the socioeconomic impacts would be similar to those currently experienced for Units 3 and 4. Therefore, the socioeconomic impacts from operating of a new nuclear power plant would be SMALL.

Transportation

During periods of peak construction activity, up to 3,900 workers would be commuting daily to the construction site. Workers commuting to the site and delivery vehicles would arrive via site access roads and the volume of traffic on nearby roads would increase substantially. The increase in vehicular traffic would peak during shift changes and during the peak building workforce use, resulting in temporary levels of service impacts and delays at intersections. In addition to the workforce, delivery vehicles transporting construction material would also use roads in the vicinity. A traffic study found that an additional 3,650 peak construction workforce and delivery vehicles for construction of Turkey Point Units 6 and 7 would not result in the exceedance capacity of local roads (along Palm Drive/SW 344th, SW 328th St, and SW 312th St) in the vicinity of the Turkey Point site; however, in order to maintain an adequate level of service for these roads, road improvements (additional turn lanes, roadway widening) would need to be implemented (Traf Tech 2009). Therefore, additional vehicles as a result of construction would noticeably alter traffic on roads in the vicinity Turkey Point, result in a loss of service for the nearby roads, and, without mitigation measures, would destabilize the transportation infrastructure. Therefore, the impact on transportation infrastructure in the immediate vicinity of the Turkey Point site during construction of a new nuclear power plant would be LARGE.

Approximately 800 workers would be commuting daily to the Turkey Point site during operations. Traffic on roadways would peak during shift changes and refueling outages, resulting in temporary levels of service impacts and delays at intersections. However, the operational and outage workforce would be similar to Turkey Point and the transportation impacts for a new nuclear alternative would be similar to what is currently being experienced as a result of operation for Units 3 and 4. Therefore, transportation impacts in the immediate vicinity of the Turkey Point site during nuclear power plant operations for the new nuclear alternative would be SMALL.

4.10.5 Natural Gas Combined-Cycle Alternative

Socioeconomics

Socioeconomic impacts would result from the approximately 1,200 construction workers and 150 workers to operate the natural gas alternative. Overall, the size of the workforce for both construction and operations would be smaller than the new nuclear alternative. The natural gas alternative would require 75 ac (30 ha) for the power block. While the natural gas alternative power block would require less land than Turkey Point, an additional 1,200 ac (490 ha) would be needed for right-of-way to connect with an existing natural gas supply line. This could result in additional property tax revenue. However, given Miami-Dade County's large funding source revenues (see Section 3.10.5 for a discussion of Miami-Dade County property tax revenues), additional property tax revenue from the natural gas alternative is not anticipated to be noticeable. The capital costs of a natural gas-fired power plant, the building and operations workforces, and the local expenditures on materials and equipment are lower at a natural-gas plant than those of a nuclear facility (EIA 2016d, EIA 2017f). Therefore, these impacts would be similar but of lesser magnitude than the new nuclear alternative. Therefore, the socioeconomic impacts from construction and operation of a natural gas alternative would be SMALL.

Transportation

Traffic-related impacts would result from the 1,200 construction workers and 150 workers during operation of the natural gas alternative, as well as delivery vehicles. The construction workforce for a natural gas-fired power plant would be less than the construction and operational workforce (when considering refueling outage workers) for a new nuclear alternative. The NRC staff concludes that the transportation impacts in the immediate vicinity of the Turkey Point site from construction would be noticeable, but not destabilizing, and therefore MODERATE.

The operations workforce for the natural gas alternative would be substantially less than the operations workforce of a new nuclear alternative. While there would be some increase in traffic in the vicinity of the Turkey Point site for the natural-gas plant during operation, that increase would be less than the increase for the new nuclear alternative. Additionally, worker vehicles from operation of the natural gas alternative would be less than what is experienced from operation of Turkey Point. The NRC staff concludes that the transportation impacts in the immediate vicinity of the Turkey Point site from operation would be SMALL.

Therefore, the NRC staff concludes that, overall, the transportation impacts in the immediate vicinity of the Turkey Point site from constructing and operating the natural gas alternative would range from SMALL to MODERATE.

4.10.6 Combination Alternative (Natural Gas Combined-Cycle and Solar Photovoltaic Generation)

Socioeconomics

The workforce required to construct and operate the natural gas portion of the combination alternative and land requirements would be similar to the full-power natural gas-only alternative discussed in Section 4.10.5 since the natural gas unit under the combination alternative would be approximately 95 percent of that of the natural gas-only alternative. Therefore, the NRC staff concludes that the socioeconomic impacts from construction and operations of the natural gas portion of the combination alternative would be SMALL.

Installation of the solar portion of the combination alternative would require up to 200 construction workers. Miami-Dade County's regional employment, tax revenue, and housing is discussed in Chapter 3, "Affected Environment." Broward County has a civilian labor force of approximately 997,404 individuals and 143,898 vacant housing units (USCB 2016h). In 2017, Broward County's property tax revenue was $0.929 billion, and its total operating revenue was $4.704 billion (Broward County 2017). A construction workforce of 200 would not result in a noticeable or substantial increase in housing demand, jobs, or wages given Miami-Dade and Broward counties' available housing and labor force. Additionally, local expenditures for goods and expenditures for construction of the solar portion would not result in noticeable tax revenue given both Miami-Dade and Broward counties' large funding source revenues. Therefore, the socioeconomic impacts from constructing the solar portion would be SMALL.

A small number of workers would be needed to maintain and operate the solar systems (10 workers). This would not result in a noticeable or substantial increase in housing demand, jobs, or wages. Operation of solar systems would generate tax revenue from operation expenditures and the large amount of land required to support this alternative (total of 1,410 ac). However, Miami-Dade and Broward counties both have large funding source revenues. The additional tax revenue from operation of solar units is not anticipated to be noticeable given both counties' revenues. Therefore, the socioeconomic impacts from operation of the solar portion of the combination alternative would be SMALL.

Transportation

Traffic-related impacts for the natural gas portion of the combination alternative would result from worker and delivery vehicles. Since the workforce required to construct and operate the natural gas power plant component of the combination alternative would be approximately the same as the natural gas-only alternative discussed in Section 4.10.5, the NRC staff concludes that the overall transportation impacts in the immediate vicinity of the Turkey Point site from constructing and operating the natural gas portion of the combination alternative would be SMALL to MODERATE.

In addition to delivery vehicles, the solar component of the combination alternative would require an estimated 200 workers during construction and 10 workers during operation. The construction and operations workforce would not result in a substantial increase in traffic in the vicinity of the Turkey Point site. An additional 200 worker vehicles during construction at the two additional sites in Broward County could be noticeable depending on the exact location of the sites and access roads and result in level of service changes and therefore impacts could be SMALL to MODERATE. However, an additional 10 worker vehicles during operations is not anticipated to have noticeable changes in traffic; the transportation impacts from operation of the solar portion of the combination alternative would be SMALL. Therefore, the staff concludes that the overall transportation impacts from constructing and operating the solar component of the combination alterative would be SMALL to MODERATE.

4.10.7 Cooling Water System Alternative

4.10.7.1 Socioeconomics

Site preparation, necessary plant modifications, and cooling tower installation would result in short-term employment increases. The workforce necessary to construct a closed-cycle mechanical-draft cooling tower system at Turkey Point is unknown. Construction workforce estimates on the construction of cooling tower technologies have been prepared for other nuclear power plants. A mechanical-draft cooling tower system consisting of two cooling tower units at the Oyster Creek Nuclear Generating Station (single unit) was estimated to require 100 workers during non-peak construction months (NRC 2006b). Bechtel (2014) estimated that for a closed-cycle cooling alternative (consisting of two wet mechanical draft cooling towers per unit) at Diablo Canyon Power Plant, approximately 1,117 construction workers (585 workers per shift and 2 work shifts) would be needed. Based on these estimates, construction of cooling towers at Turkey Point could require approximately between 200 and 1,110 construction workers.

The majority of construction workers would relocate temporarily to Miami-Dade County, resulting in a short-term increase in the population and increased demand for temporary housing. However, given Miami-Dade County's population and available housing (see Sections 3.10.3, 3.10.3.1, and 3.10.4) an additional 1,110 construction workers would not result in a noticeable increase in population or shortages in temporary housing. Estimated cooling tower construction costs for Turkey Point Units 3 and 4 have varied and ranged from \$323.5 million to \$1.84 billion (High Bridge Associates undated). For purposes of estimating the tax benefits from constructing the cooling towers in this socioeconomic analysis, the NRC staff used the construction cost (\$12.8 billion to \$18.7 billion) of the new nuclear alternative discussed in Section 4.10.4 as a bounding analysis for the construction of the cooling water system alternative. As discussed in Section 4.10.4, increases in corporate income and excise taxes, sales taxes, and wages as a result of construction would be beneficial but relatively minor.

Furthermore, the construction workforce for the cooling water system alternative is one third of the new nuclear alternative construction workforce. Therefore, the socioeconomic impacts of constructing the cooling water system alternative would be SMALL.

Once the construction of the closed-cycle cooling towers and plant modifications has been completed, the size of the workforce at Turkey Point would return to normal. A small number of additional workers would likely be needed to maintain and monitor the cooling towers. At Oyster Creek Nuclear Generating Station (single unit), an additional 25 employees were estimated to be needed for operation of the closed-cycle cooling system (NRC 2006b). Therefore, 50 additional operations workers would be a reasonable estimate for the number of additional employees needed at Turkey Point Units 3 and 4. This would result in no noticeable increase in population or housing demand. Annual property taxes could increase with an increased assessed value of Turkey Point with the addition of the cooling water system alternative. However, additional revenue generated from operating the cooling water system alternative would not be noticeable. Therefore, the socioeconomic impacts of operating the cooling water system alternative would be SMALL.

4.10.7.2 Transportation

Transportation impacts associated with the construction and operation of the cooling water system alternative would consist of commuting workers and truck deliveries of construction materials to the Turkey Point site. Construction of the cooling water system alternative at Turkey Point could require up to 1,110 construction workers. The increase in vehicular traffic would peak during shift changes, resulting in temporary levels of service impacts and delays on local roads and at intersections. Up to 1,110 construction workers, in addition to the existing Turkey Point Units 3 and 4 workforce, commuting to the site would noticeably increase traffic on the roads. Therefore, transportation impacts in the immediate vicinity of the Turkey Point site during construction of the cooling towers could range from SMALL to MODERATE and would depend on the number of worker vehicles and truck deliveries. Once the construction of the cooling towers and plant modifications has been completed, the size of the workforce and truck deliveries would return to normal. A small number of additional workers may be needed to maintain and monitor the cooling towers. Operation of the closed-cycle cooling system would have little to no effect on transportation infrastructure and, therefore, transportation impacts would be SMALL.

Overall, transportation impacts in the immediate vicinity of the Turkey Point site from the construction and operation of the cooling water system alternative could range from SMALL to MODERATE.

4.11 <u>Human Health</u>

This section describes the potential human health impacts of the proposed action (subsequent license renewal) and alternatives to the proposed action.

4.11.1 Proposed Action

According to the GEIS (NRC 1996 and NRC 2013a), the generic issues related to human health as identified in Table 4-1 would have SMALL impacts resulting from license renewal. As discussed in Chapter 3, the NRC staff identified no new and significant information for these issues. Thus, as concluded in the GEIS, the impacts of those generic issues related to human health would be SMALL.

Table 4-2 identifies one uncategorized issue (chronic exposure to electromagnetic fields) and one site-specific (Category 2) issue (electric shock hazards) related to human health applicable to Turkey Point subsequent license renewal. These issues are analyzed below.

4.11.1.1 Uncategorized Issue Relating to Human Health: Chronic Effects of Electromagnetic Fields (EMFs)

The GEIS (NUREG-1437) (NRC 2013a) does not designate the chronic effects of 60-Hz electromagnetic fields (EMFs) from power lines as either a Category 1 or Category 2 issue. Until a scientific consensus is reached on the health implications of electromagnetic fields, the NRC will not include them as Category 1 or 2 issues.

The potential for chronic effects from these fields continues to be studied and is not known at this time. The National Institute of Environmental Health Sciences (NIEHS) directs related research through the DOE.

The report by the National Institute of Environmental Health Sciences, “NIEHS Report on Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields” (NIEHS 1999), contains the following conclusion:

> The NIEHS concludes that ELF-EMF [extremely low frequency-electromagnetic field] exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. In our opinion, this finding is insufficient to warrant aggressive regulatory concern. However, because virtually everyone in the United States uses electricity and therefore is routinely exposed to ELF-EMF, passive regulatory action is warranted such as continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. The NIEHS does not believe that other cancers or non-cancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

This statement was not sufficient to cause the NRC to change its position with respect to the chronic effects of electromagnetic fields. The NRC staff considers the GEIS finding of “UNCERTAIN” still appropriate and will continue to follow developments on this issue.

4.11.1.2 Category 2 Issue Related to Human Health: Electric Shock Hazards

Based on the GEIS (NUREG-1437) (NRC 2013a), the Commission found that electric shock resulting from direct access to energized conductors or from induced charges in metallic structures has not been identified to be a problem at most operating plants and generally is not expected to be a problem during the subsequent license renewal term. However, a site-specific review is required to determine the significance of the electric shock potential along the portions of the transmission lines that are within the scope of the Turkey Point subsequent license renewal review.

As discussed in Section 3.11.4, “Electromagnetic Fields,” there are no offsite transmission lines that are in scope for this SEIS. Therefore, there are no potential impacts to members of the public.

As discussed in Section 3.11.5, “Other Hazards,” Turkey Point maintains an occupational safety program for its workers in accordance with Occupational Safety & Health Administration regulations, which includes protection from acute electric shock. Therefore, the NRC staff concludes that the potential impacts from acute electric shock during the subsequent license renewal term would be SMALL.

4.11.1.3 Environmental Consequences of Postulated Accidents

The GEIS (NUREG-1437) (NRC 2013a) evaluates the following two classes of postulated accidents as they relate to license renewal:

- Design-Basis Accidents: Postulated accidents that a nuclear facility must be designed and built to withstand without loss to the systems, structures, and components necessary to ensure public health and safety.
- Severe Accidents: Postulated accidents that are more severe than design-basis accidents because they could result in substantial damage to the reactor core, whether or not there are serious off-site consequences.

As shown in Table 4-1, the GEIS (NRC 2013a) addresses design-basis accidents as a Category 1 issue and concludes that the environmental impacts of design-basis accidents are of SMALL significance for all nuclear power plants.

As shown in Table 4-2, the GEIS designates severe accidents as a Category 2 issue requiring site-specific analysis. Based on information in the 2013 GEIS, the NRC determined in 10 CFR Part 51 that for all nuclear power plants, the probability-weighted consequences of severe accidents associated with license renewal are SMALL, with a caveat:

> The probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives. (NRC 2013a)

As part of its initial license renewal application submitted in 2000, FPL's environmental report included an assessment of severe accident mitigation alternatives (SAMAs) for Turkey Point (FPL 2000). During its review of FPL's initial license renewal application, the NRC staff performed a site-specific analysis of Turkey Point SAMAs and documented its findings in a supplement to the GEIS (Supplement 5, "Regarding Turkey Point Nuclear Plant, Units 3 & 4," to NUREG–1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants") (NRC 2002c). Because the staff has previously considered SAMAs for Turkey Point Units 3 and 4, FPL is not required to perform another SAMA analysis as part of its subsequent license renewal application (10 CFR 51.53(c)(3)(ii)(L)).

However, the NRC's regulations in 10 CFR Part 51, which implement Section 102(2) of the National Environmental Policy Act of 1969, as amended (NEPA), require that all applicants for license renewal submit an environmental report to the NRC and in that report identify any "new and significant information regarding the environmental impacts of license renewal of which the applicant is aware" (10 CFR 51.53(c)(3)(iv)). This includes new and significant information that could affect the environmental impacts related to postulated severe accidents or that could affect the results of a previous SAMA assessment. Accordingly, in its subsequent license renewal application environmental report, FPL evaluated areas of new and potentially significant information that could affect the environmental impact of postulated severe accidents during the subsequent license renewal period. The NRC staff provides a discussion of new information pertaining to SAMAs in Appendix E, "Environmental Impacts of Postulated Accidents," in this SEIS.

Based on the NRC staff's review and evaluation of FPL's analysis of new and potentially significant information regarding SAMAs and the staff's independent analyses as documented in Appendix E, "Environmental Impacts of Postulated Accidents," to this SEIS, the staff finds that there is no new and significant information for Turkey Point related to SAMAs.

4.11.2 No-Action Alternative

Under the no-action alternative, the NRC would not issue subsequent renewed licenses, and Turkey Point would shut down on or before the expiration of the current renewed licenses. Human health risks would be smaller following plant shutdown. The reactor units, which currently operate within regulatory limits, would emit less radioactive gaseous, liquid, and solid material to the environment. In addition, following shutdown, the variety of potential accidents at the plant (radiological or industrial) would be reduced to a limited set associated with shutdown events and fuel handling and storage. In Section 4.11.1, "Proposed Action," the NRC staff concluded that the impacts of continued plant operation on human health would be SMALL, except for "Chronic effects of electromagnetic fields (EMFs)," for which the impacts are UNCERTAIN. In Section 4.11.1.3, "Environmental Consequences of Postulated Accidents," the NRC staff concluded that the impacts of accidents during operation are SMALL. Therefore, as radioactive emissions to the environment decrease, and as the likelihood and types of accidents decrease following shutdown, the NRC staff concludes that the risk to human health following plant shutdown would be SMALL.

4.11.3 Replacement Power Alternatives: Common Impacts

Impacts on human health from construction of a replacement power station would be similar to impacts associated with the construction of any major industrial facility. Compliance with worker protection rules, the use of personal protective equipment, training, and placement of engineered barriers would limit those impacts on workers to acceptable levels.

The human health impacts from the operation of a power station include public risk from inhalation of gaseous emissions. Regulatory agencies, including the EPA and Florida State agencies, base air emission standards and requirements on human health impacts. These agencies also impose site-specific emission limits to protect human health.

4.11.4 New Nuclear Alternative

The construction impacts of the new nuclear alternative would include those identified in Section 4.11.3 above. Since the NRC staff expects that the licensee would limit access to active construction areas to only authorized individuals, the impacts on human health from the construction of the new nuclear alternative would be SMALL.

The human health effects from the operation of the new nuclear alternative would be similar to those of operating the existing Turkey Point Units 3 and 4. As presented in Section 4.11.1, impacts on human health from the operation of Turkey Point would be SMALL, except for "chronic effects of electromagnetic fields (EMFs)," for which the impacts are UNCERTAIN. Therefore, the NRC staff concludes that the impacts on human health from the operation of the new nuclear alternative would be SMALL.

4.11.5 Natural Gas Combined-Cycle Alternative

The construction impacts of the natural gas alternative would include those identified in Section 4.11.3, "Replacement Power Alternatives: Common Impacts," as common to the construction of all replacement power alternatives. Since the NRC staff expects that the builder will limit access to the active construction area to only authorized individuals, the impacts on human health from the construction of the natural gas alternative would be SMALL.

The human health effects from the operation of the natural gas alternative would include those identified in Section 4.11.3 as common to the operation of all replacement power alternatives. Health risk may be attributable to nitrogen oxide emissions that contribute to ozone formation (NRC 2013a). Given the regulatory oversight exercised by the EPA and State agencies, the NRC staff concludes that the human health impacts from the natural gas alternative would be SMALL.

4.11.6 Combination Alternative (Natural Gas Combined-Cycle and Solar Photovoltaic Generation)

Impacts on human health from construction of the combination natural gas and solar alternative would include those identified in Section 4.11.3 as common to the construction of all replacement power alternatives. Since the NRC staff expects that the builder will limit access to the active construction area to only authorized individuals, the impacts on human health from the construction of the combination natural gas and solar alternative would be SMALL.

Operational hazards at a natural gas facility are discussed in Section 4.11.5, "Natural Gas Combined-Cycle Alternative."

Solar photovoltaic panels are encased in heavy-duty glass or plastic. Due to this, there is little risk that the small amounts of hazardous semiconductor material that they contain will be released into the environment. In the event of a fire, hazardous particulate matter could be released to the atmosphere. Given the short duration of fires and the high melting points of the materials found in the solar photovoltaic panels, the impacts from inhalation are minimal. Also, the risk of fire at ground-mounted solar installations is minimal due to precautions taken during site preparation, such as the removal of fuels and the lack of burnable materials contained in the solar photovoltaic panels. Another potential risk associated with photovoltaic systems and fire is the potential for shock or electrocution from contact with a high voltage conductor. Proper procedures and clear marking of system components should be used to provide emergency responders with appropriate warnings to diminish the risk of shock or electrocution (OIPP 2010).

Photovoltaic solar panels do not produce electromagnetic fields at levels considered harmful to human health as established by the International Commission on Non-Ionizing Radiation Protection. These small electromagnetic fields diminish significantly with distance and are indistinguishable from normal background levels within several yards (OIPP 2010).

Therefore, given the expected compliance with worker and environmental protection rules and the use of personal protective equipment, training, and engineered barriers, the NRC staff concludes that the potential human health impacts for the combination natural gas and solar alternative would be SMALL.

4.11.7 Cooling Water System Alternative

The impacts of the cooling water system alternative would be similar to those identified in Section 4.11.3, "Replacement Power Alternatives: Common Impacts," as common to all alternatives. Limiting access to the active construction area to only authorized individuals is expected.

The human health effects from the operation of the cooling water system alternative would include microbiological organisms and exposure to any biocides added to the system to limit the growth of those microbiological organisms. The GEIS (NUREG-1437) evaluation of health effects from plants with cooling systems discusses the potential hazard to workers from microbiological organisms inhabiting the system whose presence might be enhanced by the thermal conditions found in the cooling system. The microbiological organisms of concern are freshwater organisms that are present at sites that use cooling ponds, lakes, or canals and that discharge to small rivers (NRC 2013a). These concerns would not apply to the cooling water system alternative at Turkey Point, which would be closed cycle, would use treated, reclaimed wastewater, and would not be accessible by members of the public. Also, the cooling system would contain cooling water treatment and conditioning chemical residuals (e.g., biocides, corrosion inhibitors) necessary for proper operation, maintenance, and microorganism control of the cooling towers and Turkey Point circulating water system. Incoming makeup water for the cooling water system alternative will be treated reclaimed wastewater that will be stored in an onsite reservoir. FPL has procedures onsite for the safe handling of any chemical usage for operations, and any chemical use for the cooling water alternative is expected to be added to these procedures. Also, the NRC staff assumes that any blowdown produced by the cooling towers would be disposed of by deep well injection into the Boulder Zone, which would be regulated under a Class I underground injection control permit issued by the FDEP (FAC 62-528).

In consideration of the information and assumptions presented above, the NRC staff concludes that the impacts on human health from the construction and operation of the cooling water system alternative would be SMALL.

4.12 <u>Environmental Justice</u>

In Section 3.12, "Environmental Justice," of this SEIS, the NRC staff explains the basis for its consideration of environmental justice impacts in an EIS and identifies environmental justice populations (i.e., minority and low-income populations) within a 50-mi (80-km) radius of Turkey Point. In this section, the staff describes the potential human health and environmental effects of the proposed action (subsequent license renewal) and alternatives to the proposed action on minority and low-income populations.

4.12.1 Proposed Action

The NRC addresses environmental justice matters for license renewal (including subsequent license renewal) by (1) identifying the location of minority and low-income populations that may be affected by the continued operation of the nuclear power plant during the subsequent license renewal term, (2) determining whether there would be any potential human health or environmental effects to these populations or to special pathway receptors (groups or individuals with unique consumption practices and interactions with the environment), and (3) determining whether any of the effects may be disproportionately high and adverse. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionately high environmental effects refer to impacts or risks of impacts on the natural or physical environment in a minority or low-income community that are significant and appreciably exceed the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts.

Figure 3-38 and Figure 3-39 show the location of predominantly minority and low-income population block groups residing within a 50-mi (80-km) radius of Turkey Point. This area of impact is consistent with the 50-mi (80-km) impact analysis for public and occupational health and safety. This chapter (Chapter 4) of the SEIS presents the assessment of environmental and human health impacts for each resource area. The analyses of impacts for environmental resource areas indicated that groundwater use conflicts would be SMALL to MODERATE because FPL's continued operation of its Upper Floridan aquifer production wells is likely to affect offsite well systems by increasing drawdown in the aquifer. However, as discussed in Section 4.5.1.2.2 of this SEIS, while projected drawdowns would noticeably affect the Upper Floridan aquifer, FPL's continued withdrawals would not be likely to destabilize the groundwater resource or impair the use by other users and well systems during the subsequent license renewal period. Therefore, these impacts would not be high and adverse. Additionally, the staff's analysis identified SMALL to MODERATE impacts for impingement and entrainment of aquatic organisms and thermal impacts on aquatic organisms in the CCS. As discussed in Section 4.7.1.1, the impacts are unlikely to create effects great enough to destabilize important attributes of the aquatic environment over the course of the subsequent license renewal term because the CCS aquatic community is composed of common species that exhibit no unique ecological value or niche and have no commercial or recreational value. The SMALL to MODERATE finding applies to only those aquatic resources occurring in the CCS, to which the public has no access. Impingement and entrainment and thermal effects do not apply to aquatic organisms inhabiting Biscayne Bay or other natural waterbodies because there are no surface water connections that allow flow between these waters and the CCS. Therefore, the impacts on aquatic resources would not be disproportionately high and adverse.

Potential impacts on minority and low-income populations (including migrant workers or Native Americans) would mostly consist of socioeconomic and radiological effects; however, radiation doses from continued operations during the subsequent license renewal term are expected to continue at current levels and would remain within regulatory limits. Section 4.11.1.3, "Environmental Consequences of Postulated Accidents," discusses the environmental impacts from severe accidents that might occur during the subsequent license renewal term. The Commission has determined that the probability-weighted consequences of severe accidents are SMALL. Therefore, these impacts would not be high and adverse.

Subsistence Consumption of Fish and Wildlife

As part of addressing environmental justice concerns associated with subsequent license renewal, the NRC staff assessed the potential radiological risk to special population groups (such as migrant workers or Native Americans) from exposure to radioactive material received through their unique consumption practices and interactions with the environment, including the subsistence consumption of fish, wildlife, and native vegetation; contact with surface waters, sediments, and local produce; absorption of contaminants in sediments through the skin; and inhalation of airborne radioactive material released from the plant during routine operation. The special pathway receptors analysis is an important part of the environmental justice analysis because consumption patterns may reflect the traditional or cultural practices of minority and low-income populations in the area. The results of this analysis are presented here.

Section 4-4 of Executive Order 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations” (59 FR 7629), directs Federal agencies, whenever practical and appropriate, to collect and analyze information about the consumption patterns of populations that rely principally on fish and wildlife for subsistence and to communicate the risks of these consumption patterns to the public. As part of the environmental review pertaining to the proposed new Turkey Point Units 6 and 7, the NRC staff concluded that subsistence activities are typically not conducted by minority or low-income populations in the vicinity of Turkey Point (NRC 2016a). As noted in Section 3.12 of this SEIS, according to the Census Bureau’s 2010 Census data, the largest minority population residing within a 50-mi (80-km) radius of Turkey Point is Hispanic or Latino of any race (approximately 55 percent). In an effort to overcome potential language barriers and engage Hispanic or Latino populations at the scoping and draft SEIS public meetings for Turkey Point Units 3 and 4, the NRC staff provided paper copies of the presentation material in Spanish, and an NRC Spanish speaking representative was available at the public meetings to address questions from members of the public. Unique patterns of consumption of natural resources were not identified during the scoping process or in draft SEIS public meetings or comments. In this SEIS, the NRC staff considered whether there were any means for minority or low-income populations to be disproportionately affected by examining impacts on American Indians, Hispanics, migrant workers, and other traditional lifestyle special pathway receptors. The assessment of special pathways considered the levels of radiological and non-radiological contaminants in fish, sediments, water, milk, and food products on or near Turkey Point.

Radionuclides released to the atmosphere may deposit on soil and vegetation and may therefore eventually be incorporated into the human food chain. To assess the impact of Turkey Point operations to humans from the ingestion pathway, FPL collects and analyzes samples of air, water, sediment, fish, vegetation, and milk, if available, for radioactivity as part of its ongoing, comprehensive Radiological Environmental Monitoring Program.

To assess the impact of nuclear power plant operations on the environment, FPL collects samples annually from the environment and analyzes the samples for radioactivity. Two types of samples are collected. The first type, a control sample, is collected from areas that are beyond the influence of the nuclear power plant or any other nuclear facility. These control samples are used as reference data to determine normal background levels of radiation in the environment. The second type of samples, indicator samples, are collected near the nuclear power plant from areas where any radioactivity contribution from the nuclear power plant will be at its highest concentration. These indicator samples are then compared to the control samples to evaluate the contribution of nuclear power plant operations to radiation or radioactivity levels in the environment. An effect would be indicated if the radioactivity levels detected in an indicator sample were higher than the control sample or background levels.

FPL collected air samples and samples from the aquatic, and terrestrial environment near Turkey Point in 2017. The aquatic pathways sampled include surface water, shoreline sediment, and fish.

Aquatic monitoring results for 2017 were consistent with previous levels and, except for tritium in surface and groundwater, yielded no indication of nuclides attributable to Turkey Point operation. Tritium was reported in surface and groundwater samples. Tritium concentrations in water samples were below reporting limits as specified by Turkey Point’s Offsite Dose

Calculation Manual (30,000 pCi/L) and EPA's public drinking water standard (20,000 pCi/L) (FPL 2013a, FPL 2018j, 40 CFR 141.66). Tritium occurs in underlying groundwater beneath the CCS as well as in adjacent areas beneath the Turkey Point plant complex. Because the canals comprising the CCS are not lined, CCS water containing tritium migrates into the groundwater of the underlying Biscayne aquifer. Sections 3.5.2.2 and 4.5.1.2 of this SEIS discuss groundwater tritium levels in the vicinity of the Turkey Point site and Turkey Point's Groundwater Protection Program in greater detail. As stated in Section 4.5.1.2, at no location outside the boundary of the Turkey Point site do tritium levels in groundwater approach the EPA and State primary drinking water standard for tritium (20,000 pCi/L), while the highest tritium levels in offsite monitoring wells near the site were at 15 percent of the standard.

Terrestrial monitoring results for 2017 of broad leaf vegetation were consistent with previous levels. Cesium-137 was detected in samples collected and it was below reporting limits as specified by Turkey Point's Offsite Dose Calculation Manual. Cesium-137 could be associated with fallout from past atmospheric nuclear weapons and reactor accidents (FPL 2018j). Milk samples were not available for testing.

Based on the radiological environmental monitoring data from Turkey Point, special pathway receptor populations in the region are not expected to experience disproportionately high and adverse human health impacts as a result of subsistence consumption of water, local food, fish, and wildlife.

4.12.2 No-Action Alternative

Under the no-action alternative, the NRC would not issue subsequent renewed licenses, and Turkey Point would shut down on or before the expiration of the current renewed licenses. Impacts on minority and low-income populations would include loss of jobs, reduction in tax revenue, and potentially a reduction in public services. A decrease in the availability of services could disproportionately affect minority and low-income populations that may have become dependent on these services. However, as discussed in Section 4.10.2, "No-Action Alternative," of this SEIS, because of the large population, labor force, and tax revenue of Miami-Dade County, the socioeconomic impacts from not issuing the subsequent renewed licenses and terminating reactor operations at Turkey Point would be SMALL. Therefore, under the no-action alternative, the effects to minority and low-income populations would not be disproportionately high and adverse.

4.12.3 Replacement Power Alternatives: Common Impacts

Construction

Potential impacts to minority and low-income populations from the construction of a new replacement power plant would mostly consist of environmental and socioeconomic effects (e.g., noise, air emissions, traffic, employment, and housing impacts). Figure 3-38 and Figure 3-39 show the location of predominantly minority and low-income population block groups residing within a 50-mi (80-km) radius of Turkey Point. Minority and low-income populations residing along site access roads could be affected by increased truck traffic and increased commuter vehicle traffic, especially during shift changes. However, a 2017 land-use survey within a 5-mi radius of Turkey Point identified few residents in the vicinity of the Turkey Point site; the nearest resident is approximately 1.9 mi (3.0 km) away from the site at the Homestead Bayfront Park complex; the nearest residential communities are in Homestead, approximately 6.0 mi (9.7 km) west of the site (FPL 2018k). During the environmental site audit, the NRC staff confirmed that there are few residents along site access roads in the immediate vicinity of the Turkey Point site, in particular Palm Drive. Therefore, increased traffic along site access roads is not likely to affect minority and low-income populations.

Noise would result from construction equipment, site activities, and additional traffic. Migrant agricultural workers (see Section 3.10.3.2, "Migrant Farm Workers," of this SEIS) could be particularly vulnerable to noise impacts because of their outdoor presence. However, the nearest farm is approximately 4.5 mi (7.2 km) away from Turkey Point (FPL 2018j); and the NRC staff has determined that noise would be temporary and not significant, and that noise levels would be lessened by distance. Air emissions would result from increased vehicle traffic, construction equipment, and fugitive dust from construction activities. These emissions would be temporary and minor (see Section 4.3.3, "Replacement Power Alternatives: Common Impacts," of this SEIS). Increased demand for rental housing during construction could disproportionately affect low-income populations. However, there is a large housing stock available in Miami-Dade County (see Table 3-20 and Table 3-22).

<u>Operation</u>

Low-income populations living near the power plant that rely on subsistence consumption of fish and wildlife could be disproportionately affected by replacement power alternatives. Emissions during power plant operations could disproportionately affect nearby minority and low-income populations, depending on the type of replacement power. Noise, primarily associated with cooling towers and vehicle traffic, would be intermittent and not noticeable.

4.12.3.1 New Nuclear Alternative

Potential impacts to minority and low-income populations from the construction and operation of the new nuclear alternative on the Turkey Point site would be similar to the impacts discussed above in Section 4.12.3 as common to all replacement power alternatives. While transportation impacts on access roads in the immediate vicinity of Turkey Point during construction of a new nuclear alternative would be LARGE, there are few residents along site access roads in the immediate vicinity of the Turkey Point site and the nearest residential community is in Homestead, approximately 6.0 mi (9.7 km) from the site. Potential impacts from operation would mostly consist of radionuclide releases and effects during operations; however, radiation doses would be required to meet regulatory limits, similar to the current operation of Turkey Point.

Based on (1) the location of the new nuclear alternative, (2) the assumed plant design and characteristics, and (3) the human health and environmental effects findings, construction and operation of the new nuclear alternative would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

4.12.3.2 Natural Gas Combined-Cycle Alternative

Potential impacts to minority and low-income populations from the construction and operation of the natural gas alternative on the Turkey Point site would be similar to the impacts discussed above in Section 4.12.3 as common to all replacement power alternatives. While transportation impacts on access roads in the immediate vicinity of Turkey Point during construction of a natural gas alternative would be MODERATE, there are few residents along site access roads in the vicinity of the Turkey Point site and the nearest residential community is in Homestead, approximately 6.0 mi (9.7 km) from the site. As noted in Section 3.12, "Environmental Justice," of this SEIS and in Figure 3-38 and Figure 3-39, the Turkey Point site is in a minority and low-income population block group where the minority population exceeds 78 percent. As discussed in Section 4.3.5, "Natural Gas Combined-Cycle," of this SEIS, nitrogen oxide and greenhouse gas emissions from a natural gas combined-cycle plant would be significant. Therefore, there would be a high concentration of minorities in close proximity to the source of air emissions. However, as discussed in Section 4.3.5, "Natural Gas Combined-Cycle," of this SEIS, emissions would be noticeable but not destabilizing. Therefore, these effects are not likely to be high and adverse and emissions from the natural gas alternative during power plant operation are not likely to disproportionately affect minority populations living in the vicinity of the new power plant.

Based on (1) the location of the natural gas alternative, (2) the assumed plant design and characteristics, and (3) the human health and environmental effects findings, construction and operation of the natural gas alternative would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

4.12.3.3 Combination Alternative (Natural Gas Combined-Cycle and Solar Photovoltaic)

Potential impacts to minority and low-income populations from the construction and operation of the natural gas portion of the combination alternative on the Turkey Point site would be the same as those discussed for the natural gas alternative (see Section 4.12.3.2 of this SEIS). Therefore, the construction and operation of the natural gas portion would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

Potential impacts to minority and low-income populations from the construction and operation of solar facilities would mostly consist of environmental and socioeconomic effects (e.g., noise, air emissions, traffic, employment, and housing impacts). Figure 3-38 and Figure 3-39 show the location of predominantly minority and low-income population block groups residing within a 50-mi (80-km) radius of Turkey Point. Three of the solar facilities would be built in Miami-Dade and/or Broward County. According to the 2010 U.S. Census, minorities comprised 56.5 percent of the total Broward County population (USCB 2010c). The 2012–2016 American Survey Community 5-Year Estimates shows that 14.4 percent of individuals in Broward County live below the poverty threshold (USCB 2018). As noted in Chapter 3, minorities comprised approximately 86 percent of the total Miami-Dade County population and 18.3 percent of individuals in Miami-Dade County live below the poverty threshold.

Noise and air emissions impacts from construction would be short term and primarily limited to onsite activities. Increased demand for rental housing during construction and operations could affect low-income populations. However, given the number of construction workers and housing availability in Miami-Dade and Broward Counties, the potential need for rental housing would not be significant. During operations, there would not be a noticeable housing demand given the small number of workers needed to maintain and operate the solar facilities. Minority and low-income populations residing along site access roads would be affected by increased commuter vehicle traffic during shift changes and truck traffic. Transportation impacts would be SMALL to MODERATE and would depend on the location of the solar facilities in Broward County. However, these effects would be temporary during certain hours of the day.

Based on this information and the analysis of human health and environmental impacts presented in this SEIS, it is not likely that the construction and operation of the solar facilities would have disproportionately high and adverse human health and environmental effects on minority and low-income populations. However, this determination would depend on the location of the facilities in Miami-Dade County and/or Broward County. Therefore, the NRC staff cannot determine whether the solar portion of the combination alternative would result in disproportionately high and adverse human health and environmental effects on minority and low-income populations.

4.12.4 Cooling Water System Alternative

Potential impacts to minority and low-income populations from the construction and operation of the cooling water system alternative would mostly consist of environmental and socioeconomic effects (e.g., noise, air emissions, traffic, employment, and housing impacts). Figure 3-38 and Figure 3-39 show the location of predominantly minority and low-income population block groups residing within a 50-mi (80-km) radius of Turkey Point. As discussed in Section 4.10.7, “Cooling Water System Alternative,” of this SEIS, transportation impacts during construction would be SMALL to MODERATE on roads in the immediate vicinity of Turkey Point. Minority and low-income populations residing along site access roads could be affected by increased truck traffic and increased commuter vehicle traffic, especially during shift changes. However, the transportation impacts would be on access roads in the immediate vicinity of Turkey Point. A 2017 land-use survey within a 5-mi (8.0 km) radius of Turkey Point identified few residents in the vicinity of the Turkey Point site; the nearest resident was approximately 1.9 mi (3.0 km) away from the site and the nearest residential communities are in Homestead, approximately 6.0 mi (9.7 km) west of the site (FPL 2018k). During the environmental site audit, the NRC staff confirmed that there are few residents along site access roads in the immediate vicinity of the Turkey Point site, in particular Palm Drive.

Noise would result from construction equipment, site activities, and additional traffic. Migrant agricultural workers (see Section 3.10.3.2, “Migrant Farm Workers,” of this SEIS) could be particularly vulnerable to noise impacts because of their outdoor presence. However, the nearest farm is approximately 4.5 mi (7.2 km) away from Turkey Point (FPL 2018j); and the NRC staff has determined that noise would be temporary, not significant, and that noise levels would be lessened by distance. Air emissions would result from increased vehicle traffic, construction equipment, and fugitive dust from construction activities. However, these emissions would be temporary and minor (see Section 4.3.4, “New Nuclear Alternative,” of this SEIS).

Replacement power will be required during the construction outage as well as a result of efficiency losses or additional power needed to operate cooling tower pumps and fans once the cooling system is online. Replacement power could increase air quality impacts and human health effects in minority and low-income communities, depending on the location and characteristics of replacement power used to replace Turkey Point power. The effects would be short lived during the construction-related outages and would occur near the existing power plants and would result from incremental increases rather than new effects. As discussed in Section 4.12.4 of this SEIS, during operations, the cooling towers would emit particulate matter, however, these emissions would be minor.

Based on the analysis of human health and environmental impacts presented in this SEIS, the location of the alternative, and the assumed alternative design and characteristics, this alternative would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

4.13 Waste Management

This section describes the potential waste management impacts of the proposed action (subsequent license renewal) and alternatives to the proposed action.

4.13.1 Proposed Action

According to the GEIS (NRC 1996, NRC 2013a), the generic issues related to waste management as identified in Table 4-1 would not be affected by continued operations associated with license renewal. As discussed in Chapter 3, the NRC staff identified no new and significant information for these issues. Thus, as concluded in the GEIS, the impacts of the generic issues related to waste management would be SMALL.

Table 4-2 does not identify any Turkey Point site-specific (Category 2) waste management issues resulting from issuing a subsequent renewed license for an additional 20 years of operations.

4.13.2 No-Action Alternative

Under the no-action alternative, the NRC would not issue subsequent renewed licenses, and Turkey Point would shut down on or before the expiration of the current renewed licenses and enter decommissioning. After plant shutdown and prior to entering the decommissioning phase, the plant would generate no additional spent nuclear fuel. In addition, following shutdown, the variety of potential accidents at the plant (radiological and industrial) would be reduced to a limited set associated with shutdown events and fuel handling and storage. Therefore, as radioactive emissions to the environment decrease, and the likelihood and variety of accidents decrease following shutdown and decommissioning, the NRC staff concludes that the impacts resulting from waste management from the implementation of the no-action alternative would be SMALL.

4.13.3 Replacement Power Alternatives: Common Impacts

Impacts from waste management common to all analyzed replacement power alternatives would be from construction-related debris generated during construction activities, and this waste would be recycled or disposed of in approved landfills.

4.13.4 New Nuclear Alternative

Impacts from the waste generated during the construction of a new nuclear unit would include those identified in Section 4.13.3, as common to all replacement power alternatives.

During normal plant operations, routine plant maintenance and cleaning activities would generate radioactive low-level waste, spent nuclear fuel, high-level waste, and nonradioactive waste. Sections 3.1.4 and 3.1.5 of this SEIS discuss radioactive and nonradioactive waste management at Turkey Point. Quantities of radioactive and nonradioactive waste generated by Turkey Point would be comparable to that generated by the new nuclear plant. As stated in the GEIS (NUREG-1437) (NRC 2013a), the NRC does not expect the generation and management of solid radioactive and nonradioactive waste during the subsequent license renewal term to result in significant environmental impacts. Based on this information, the waste impacts would be SMALL for the new nuclear alternative.

4.13.5 Natural Gas Combined-Cycle Alternative

Impacts from the waste generated during the construction of a natural gas power plant would include those identified in Section 4.13.3 of this SEIS as common to all replacement power alternatives.

Waste generation from natural gas technology would be minimal. The only significant waste generated at a natural gas combined-cycle power plant would be spent selective catalytic reduction catalyst (plants use selective catalytic reduction catalyst to control nitrogen oxide emissions).

The spent catalyst would be regenerated or disposed of offsite. Other than the spent selective catalytic reduction catalyst, waste generation at an operating natural gas fired plant would be limited largely to typical operations and maintenance nonhazardous waste (NRC 2013a). Overall, the NRC staff concludes that waste impacts from the natural gas alternative would be SMALL.

4.13.6 Combination Alternative (Natural Gas Combined-Cycle and Solar Photovoltaic Generation)

Impacts from the waste generated during the construction of the natural gas combined-cycle (NGCC) plant and solar photovoltaic (PV) alternative would include those identified in Section 4.13.3 of this SEIS as common to the construction of all replacement power alternatives. The combination alternative consists of a natural gas plant and solar PV facilities that provide generation equivalent to Turkey Point’s 1,632 MWe with an annual generation of approximately 13,154,016 MWhs. The natural gas plant would be located at the Turkey Point site. Four solar PV facilities would be constructed. One solar PV facility would be located on FPL-owned land on or near the Turkey Point site, and the other three solar facilities would be located in Miami-Dade or Broward County.

During the construction of the natural gas plant and solar PV facilities, land clearing and other construction activities would generate waste that could be recycled, disposed of onsite, or shipped to an offsite waste disposal facility.

Waste generation from natural gas technology would be minimal. The only significant waste generated at a natural gas combined-cycle power plant would be spent selective catalytic reduction catalyst (plants use selective catalytic reduction catalyst to control nitrogen oxide emissions).

The spent catalyst would be regenerated or disposed of offsite. Other than the spent selective catalytic reduction catalyst, waste generation at an operating natural gas fired plant would be limited largely to typical operations and maintenance nonhazardous waste (NRC 2013a). Overall, the NRC staff concludes that waste impacts from the natural gas portion of the combination alternative would be SMALL.

Impacts on waste management from the construction and operation of the natural gas plant and pipeline component of the combination alternative would be similar to those associated with the natural gas alternative.

The construction of the solar PV facilities would create sanitary and industrial waste, although it would be of smaller quantity as compared to the natural gas plant. This waste could be recycled, disposed of onsite, or shipped to an offsite waste disposal facility. All of the waste would be handled in accordance with appropriate FDEP regulations. Impacts on waste management resulting from the construction and operation of the solar PV facilities of the combination alternative would be minimal, and of a smaller quantity as compared to the natural gas plant. In sum, the waste management impacts resulting from the construction and operation of the PV facilities would be SMALL.

Overall, the NRC staff concludes that waste impacts for the natural gas and solar PV combination alternative would be SMALL.

4.13.7 Cooling Water System Alternative

Waste management impacts from the waste generated during the construction of the cooling water system alternative would include those identified in Section 4.13.3 as common to all replacement power alternatives.

During operation, some minor amounts of chemical wastes may result from efforts to maintain appropriate chemical quality of the recirculating cooling water, from the periodic maintenance (i.e., descaling) of the cooling towers, and from periodic removal of settled precipitates from the cooling water basins beneath each cooling tower. Operational solid wastes are expected to be temporarily stored on site or ultimately treated, recycled, or disposed in appropriately permitted offsite facilities. FPL would be expected to implement appropriate waste management practices to minimize volume and content of waste generated from the construction and operation of the cooling towers. Any cooling water treatment and conditioning chemical residuals (e.g., biocides, corrosion inhibitors) necessary for proper operation, maintenance, and microorganism control of the cooling towers and Turkey Point circulating water system would be disposed of and managed in accordance with FDEP requirements.

In consideration of the information and assumptions presented above, the NRC staff concludes that the impacts from waste management from the construction and operation of the cooling water system alternative would be SMALL.

4.14 <u>Evaluation of New and Significant Information</u>

As stated in Section 4.1, "Introduction," of this SEIS, for Category 1 (generic) issues, the NRC staff can rely on the analysis in the GEIS (NUREG-1437) (NRC 2013a) unless otherwise noted. Table 4-1 lists the Category 1 issues that apply to Turkey Point during the proposed subsequent license renewal period. The NRC staff identified and evaluated new and potentially significant information for two existing Category 1 issues (i.e., groundwater quality degradation (plants with cooling ponds in salt marshes) and cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds)) and identified one new uncategorized issue (i.e., water quality impacts on adjacent water bodies (plants with cooling ponds in salt marshes)). The NRC staff determined that the information was both new and potentially significant for one of the issues, "Groundwater quality degradation (plants with cooling ponds in salt marshes)," as listed in Table 4-1 and as evaluated in Section 4.5.1.2, "Groundwater Resources," of this SEIS. For all other issues, the NRC staff did not identify any new and significant information during its review of FPL's environmental report, the site audits, or the scoping period that would change the conclusions presented in the GEIS.

New and significant information must be new based on a review of the GEIS (NRC 2013a) as codified in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51. Such information must also bear on the proposed action or its impacts, presenting a seriously different picture of the impacts from those envisioned in the GEIS (i.e., impacts of greater severity than the impacts considered in the GEIS, considering their intensity and context).

The NRC defines new and significant information in Regulatory Guide (RG) 4.2, Supplement 1, "Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications" (NRC 2013g), as (1) information that identifies a significant environmental impact issue that was not considered or addressed in the GEIS and, consequently, not codified in Table B-1, in Appendix B to Subpart A of 10 CFR Part 51, or (2) information not considered in the assessment of impacts evaluated in the GEIS leading to a seriously different picture of the environmental consequences of the action than previously considered, such as an environmental impact finding different from that codified in Table B-1. Further, a significant environmental issue includes, but is not limited to, any new activity or aspect associated with the nuclear power plant that can act upon the environment in a manner or an intensity and/or scope (context) not previously recognized.

In accordance with 10 CFR 51.53(c), "Operating license renewal stage," the applicant's environmental report must analyze the Category 2 (site-specific) issues in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51. Additionally, the applicant's environmental report must discuss actions to mitigate any adverse impacts associated with the proposed action and environmental impacts of alternatives to the proposed action. In accordance with 10 CFR 51.53(c), the applicant's environmental report does not need to analyze any Category 1 issue unless there is new and significant information on a specific issue.

NUREG–1555, Supplement 1, Revision 1, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants for Operating License Renewal" describes the NRC process for identifying new and significant information (NRC 2013b). The search for new information includes:

- review of an applicant's environmental report (FPL 2018f, FPL 2018n) and the process for discovering and evaluating the significance of new information
- review of public comments
- review of environmental quality standards and regulations
- coordination with Federal, State, and local environmental protection and resource agencies
- review of technical literature as documented through this SEIS

New information is evaluated for significance using the criteria set forth in the GEIS. For Category 1 issues for which new and significant information is identified, reconsideration of the conclusions for those issues is limited in scope to an assessment of the relevant new and significant information; the scope of the assessment does not include other facets of an issue that the new information does not affect.

The NRC staff reviewed the discussion of environmental impacts associated with operation during the subsequent license renewal term in the GEIS and has conducted its own independent review, including a public involvement process (e.g., public meetings and comments) to identify new and significant issues for the Turkey Point subsequent license renewal application environmental review.

4.15 Impacts Common to All Alternatives

This section describes the impacts that the NRC staff considers common to all alternatives discussed in this SEIS, including the proposed action and replacement power alternatives. The continued operation of a nuclear power plant and replacement fossil fuel power plants both involve mining, processing, and the consumption of fuel that result in comparative impacts (NRC 2013a). In addition, the following sections discuss the termination of operations and the decommissioning of both a nuclear power plant and replacement fossil fuel power plants and greenhouse gas emissions.

4.15.1 Fuel Cycle

This section describes the environmental impacts associated with the fuel cycles of both the proposed action and all replacement power alternatives. Most replacement power alternatives employ a set of steps in the use of their fuel sources, which can include extraction, transformation, transportation, and combustion. Emissions generally occur at each stage of the fuel cycle (NRC 2013a).

4.15.1.1 Uranium Fuel Cycle

The uranium fuel cycle includes uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials, and management of low-level wastes and high-level wastes related to uranium fuel cycle activities. The GEIS (NUREG-1437) describes in detail the generic potential impacts of the radiological and non-radiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes (NRC 1996, NRC 1999, NRC 2013a). The GEIS does not identify any site-specific (Category 2) uranium fuel cycle issues.

As stated in the GEIS (NRC 1996, NRC 2013a), the generic issues related to the uranium fuel cycle as identified in Table 4-1 would not be affected by continued operations associated with license renewal. As discussed in Chapter 3, the NRC staff identified no new and significant information for these issues. Thus, as concluded in the GEIS, the impacts of generic issues related to the uranium fuel cycle would be SMALL.

4.15.1.2 Replacement Power Plant Fuel Cycles

<u>Fossil Fuel Energy Alternatives</u>

Fuel cycle impacts for a fossil fuel-fired plant result from the initial extraction of fuel, cleaning and processing of fuel, transport of fuel to the facility, and management and ultimate disposal of solid wastes from fuel combustion. These impacts are discussed in more detail in Section 4.12.1.2 of the GEIS (NUREG-1437) (NRC 2013a) and can generally include the following:

- significant changes to land use and visual resources
- impacts to air quality, including release of criteria pollutants, fugitive dust, volatile organic compounds, and coalbed methane into the atmosphere
- noise impacts
- geology and soil impacts due to land disturbances and mining

- water resource impacts, including degradation of surface water and groundwater quality
- ecological impacts, including loss of habitat and wildlife disturbances
- historic and cultural resources impacts within the mine or pipeline footprint
- socioeconomic impacts from employment of both the mining workforce and service and support industries
- environmental justice impacts
- health impacts to workers from exposure to airborne dust and methane gases
- generation of industrial wastes

New Nuclear Energy Alternatives

Uranium fuel cycle impacts for a nuclear plant result from the initial extraction of fuel, transport of fuel to the facility, and management and ultimate disposal of spent fuel. The environmental impacts of the uranium fuel cycle are discussed in Section 4.15.1.1 of this SEIS.

Renewable Energy Alternatives

The fuel cycle for renewable energy facilities is difficult to define for different technologies because these natural resources exist regardless of any effort to harvest them for electricity production. Impacts from the presence or absence of these renewable energy technologies are often difficult to determine (NRC 2013a).

4.15.2 Terminating Power Plant Operations and Decommissioning

This section describes the environmental impacts associated with the termination of operations and the decommissioning of a nuclear power plant and replacement power alternatives. All operating power plants will terminate operations and be decommissioned at some point after the end of their operating life or after a decision is made to cease operations. For the proposed action at Turkey Point, subsequent license renewal would delay this eventuality for an additional 20 years beyond the current license period, which ends in 2032 (Unit 3) and 2033 (Unit 4).

4.15.2.1 Existing Nuclear Power Plant

Decommissioning would occur whether Turkey Point is shut down at the end of its current renewed license or at the end of the subsequent license renewal term. NUREG–0586, Supplement 1, "Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Regarding the Decommissioning of Nuclear Power Reactors" (the Decommissioning GEIS), evaluates the environmental impacts from the activities associated with the decommissioning of any reactor before or at the end of an initial or renewed license (NRC 2002a). Additionally, the License Renewal GEIS (NUREG-1437) (NRC 2013a) discusses the incremental environmental impacts associated with decommissioning activities resulting from continued plant operation during the renewal term. As noted in Table 4-1, there is one Category 1 issue applicable to Turkey Point decommissioning following the subsequent license renewal term. The License Renewal GEIS did not identify any site-specific (Category 2) decommissioning issues.

4.15.2.2 Replacement Power Plants

Fossil Fuel Energy Alternatives

The environmental impacts from the termination of power plant operations and decommissioning of a fossil fuel-fired plant are dependent on the facility's decommissioning plan. General elements and requirements for a fossil fuel plant decommissioning plan are discussed in Section 4.12.2.2 of the License Renewal GEIS (NUREG-1437) and can include the removal of structures to at least 3 feet (1 m) below grade; removal of all coal, combustion waste, and accumulated sludge; removal of intake and discharge structures; and the cleanup and remediation of incidental spills and leaks at the facility. The decommissioning plan outlines the actions necessary to restore the site to a condition equivalent in character and value to the site on which the facility was first constructed (NRC 2013a).

The environmental consequences of decommissioning are discussed in Section 4.12.2.2 of the License Renewal GEIS (NUREG-1437) and can generally include the following:

- short-term impacts on air quality and noise from the deconstruction of facility structures
- short-term impacts on land use and visual resources
- long-term reestablishment of vegetation and wildlife communities
- socioeconomic impacts due to decommissioning the workforce and the long-term loss of jobs
- elimination of health and safety impacts on operating personnel and the general public

New Nuclear Alternatives

Termination of operations and decommissioning impacts for a nuclear plant include all activities related to the safe removal of the facility from service and the reduction of residual radioactivity to a level that permits release of the property under restricted conditions or unrestricted use and termination of a license (NRC 2013a). The environmental impacts of the uranium fuel cycle are discussed in Section 4.15.1.1, "Uranium Fuel Cycle."

Renewable Alternatives

Termination of power plant operation and decommissioning for renewable energy facilities would be similar to the impacts discussed for fossil fuel-fired plants. Decommissioning would involve the removal of facility components and operational wastes and residues to restore the site to a condition equivalent in character and value to the site on which the facility was first constructed (NRC 2013a).

4.15.3 Greenhouse Gas Emissions and Climate Change

The following sections discuss greenhouse gas emissions and climate change impacts. Section 4.15.3.1 evaluates greenhouse gas emissions associated with operation of Turkey Point Units 3 and 4 and replacement power alternatives. Section 4.15.3.2 discusses the observed changes in climate and the potential future climate change during the subsequent license renewal term based on climate model simulations under future global greenhouse gas emission scenarios. The cumulative impacts of global greenhouse gas emissions on climate are discussed in Section 4.16.10, "Global Greenhouse Gas Emissions," in this SEIS. In Section 4.16, "Cumulative Impacts," of this SEIS, the NRC staff considers the potential cumulative, or overlapping, impacts from climate change on environmental resources where there are incremental impacts of the proposed action (subsequent license renewal).

4.15.3.1 Greenhouse Gas Emissions from the Proposed Action and Alternatives

Gases found in the Earth's atmosphere that trap heat and play a role in the Earth's climate are collectively termed greenhouse gases. Greenhouse gases include carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); water vapor (H_2O); and fluorinated gases, such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). The Earth's climate responds to changes in concentrations of greenhouse gases in the atmosphere because these gases affect the amount of energy absorbed and heat trapped by the atmosphere. Increasing greenhouse gas concentrations in the atmosphere generally increase the Earth's surface temperature. Atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have significantly increased since 1750 (IPCC 2007, IPCC 2013). Carbon dioxide, methane, nitrous oxide, water vapor, and fluorinated gases (termed long-lived greenhouse gases) are well mixed throughout the Earth's atmosphere, and their impact on climate is long lasting as a result of their long atmospheric lifetime (EPA 2009b). Carbon dioxide is of primary concern for global climate change, due to its long atmospheric lifetime, and it is the primary gas emitted as a result of human activities. Climate change research indicates that the cause of the Earth's warming over the last 50 years is due to the buildup of greenhouse gases in the atmosphere resulting from human activities (IPCC 2013, USGCRP 2014, USGCRP 2017). The EPA has determined that greenhouse gases "may reasonably be anticipated both to endanger public health and to endanger public welfare" (74 FR 66496).

Proposed Action

Operation of Turkey Point emits greenhouse gases directly and indirectly. Turkey Point's direct greenhouse gas emissions result from stationary portable combustion sources (see Table 3-2) and stationary refrigeration appliances. Indirect greenhouse gas emissions originate from mobile combustion sources (e.g., employee vehicles, visitor vehicles, and delivery vehicles). Table 4-6 below presents quantified annual greenhouse gas emissions from sources at Turkey Point.

FPL does not maintain an inventory of greenhouse gas emissions resulting from visitor and delivery vehicles. Chlorofluorocarbon and hydrochlorofluorocarbon emissions from refrigerant sources can result from leakage, servicing, repair, or disposal of refrigerant sources. Chlorofluorocarbons and hydrochlorofluorocarbons are ozone-depleting substances that are regulated by the Clean Air Act under Title VI, "Stratospheric Ozone Protection." FPL maintains a program to manage stationary refrigeration appliances at Turkey Point to recycle, recapture, and reduce emissions of ozone-depleting substances (FPL 2018f). Estimating greenhouse gas emissions from refrigerant sources is complicated due to their ability to deplete ozone, which is also a greenhouse gas, making their global warming potentials difficult to quantify. Consequently, greenhouse gas emissions from refrigerant sources are commonly excluded from greenhouse gas inventories (EPA 2014d). Therefore, Table 4-6 does not account for potential greenhouse gas emissions from stationary refrigeration appliances or visitor and delivery vehicles at Turkey Point.

Table 4-6 Estimated Greenhouse Gas Emissions[a] from Operation at Turkey Point, Units 3 and 4

Year	Turkey Point Combustion Sources[b] (tons/year)	Workforce Commuting[c] (tons/year)	Total (tons/year)
2012	570	3,400	3,970
2013	500	3,400	3,900
2014	620	3,400	4,020
2015	790	3,400	4,190
2016	540	3,400	3,940

Note: GHG emissions reported in metric tons and converted to short tons. All reported values are rounded. To convert tons per year to metric tons per year, multiply by 0.90718.

[a] Expressed in carbon dioxide equivalents (CO2eq), a metric used to compare the emissions of greenhouse gases (GHG) based on their global warming potential (GWP). The GWP is a measure used to compare how much heat a GHG traps in the atmosphere. The GWP is the total energy that a gas absorbs over a period of time compared to carbon dioxide. CO2eq is obtained by multiplying the amount of the GHG by the associated GWP. For example, the GWP of methane is 21; therefore, 1 ton of methane is equivalent to 21 tons of carbon dioxide emissions.

[b] Includes stationary and portable diesel and gasoline engines described in Table 3-2..

[c] Emissions consider Turkey Point full-time employees and does not include additional contractor workers during refueling outages. Refueling outages occur on a staggered, 18-month schedule and last approximately 25–35 days per unit.

Source: Modified from FPL 2018f

<u>No-Action Alternative</u>

Under the no-action alternative, the NRC would not issue subsequent renewed licenses, and Turkey Point Units 3 and 4 would shut down on or before the expiration of the current renewed licenses. At some point, all nuclear plants will terminate operations and undergo decommissioning. The Decommissioning GEIS (NUREG–0586, NRC 2002a) considers the impacts from decommissioning. Therefore, the scope of impacts considered under the no-action alternative includes the immediate impacts resulting from activities at Turkey Point that would occur between plant shutdown and the beginning of decommissioning (i.e., activities and actions necessary to cease operation of Turkey Point). Turkey Point operations would terminate at or before the expiration of the current renewed licenses. When the plant stops operating, a reduction in greenhouse gas emissions from activities related to plant operation, such as the use of diesel generators and employee vehicles, would occur. The NRC staff anticipates that greenhouse gas emissions for the no-action alternative would be less than those presented in Table 4-6, which shows the estimated greenhouse gas emissions from operation of Turkey Point Units 3 and 4.

Since the no-action alternative would result in a loss of power generating capacity due to shutdown, the sections below discuss greenhouse gas emissions associated with replacement baseload power generation for each replacement power alternative analyzed.

New Nuclear Alternative

The license renewal GEIS (NUREG-1437) presents life-cycle greenhouse gas emissions associated with nuclear power generation. As presented in Tables 4.12-4 through 4.12-6 of the GEIS (NRC 2013a), life-cycle greenhouse gas emissions from nuclear power generation can range from 1 to 288 grams carbon equivalent per kilowatt-hour (g C_{eq}/kWh). Nuclear power plants do not burn fossil fuels to generate electricity. Sources of greenhouse gas emissions from the new nuclear alternative would include stationary combustion sources such as emergency diesel generators, boilers, and pumps similar to existing sources at Turkey Point (see Section 3.2.1 of this SEIS). The NRC staff estimates that greenhouse gas emissions from a new nuclear alternative would be similar to greenhouse gas emissions from Turkey Point.

Natural Gas Combined-Cycle Alternative

The GEIS (NRC 2013a) presents life-cycle greenhouse gas emissions associated with natural gas power generation. As presented in Table 4.12-5 of the GEIS, life-cycle greenhouse gas emissions from natural gas can range from 120 to 930 g C_{eq}/kWh. The NRC staff estimates that direct emissions from the operation of three, 500-MWe natural gas combined-cycle units would total 5.7 million tons (5.2 million MT) of carbon dioxide equivalents (CO_{2eq}) per year.

Combination Alternative

For the combination alternative, greenhouse gases would primarily be emitted from the natural gas component of this alternative. The NRC staff estimates that the operation of the natural gas-fired units would emit a total of 5.4 million tons (4.9 million MT) of CO_{2eq} per year.

Summary of Greenhouse Gas Emissions from the Proposed Action and Alternatives

Table 4-7 below presents the direct greenhouse gas emissions from facility operations under the proposed action of subsequent license renewal and alternatives to the proposed action. Greenhouse gas emissions from the proposed action (subsequent license renewal), the no-action alternative, and the new nuclear alternative would be the lowest. Greenhouse gas emissions from the natural gas and combination alternatives are several orders of magnitude greater than those from the continued operation of Turkey Point. Therefore, if Turkey Point's generating capacity were to be replaced by either of these two alternatives, there would be an increase in greenhouse gas emissions. Consequently, the continued operation of Turkey Point (the proposed action) results in greenhouse gas emissions avoidance as compared to the natural gas or combination alternative.

Table 4-7 Direct Greenhouse Gas Emissions from Facility Operations Under the Proposed Action and Alternatives

Technology/Alternative	CO_{2eq}[(a)] (tons/year)
Proposed Action (Turkey Point subsequent license renewal)[(b)]	604
No-Action Alternative[(c)]	<604
New Nuclear[(d)]	604
Natural Gas Combined-Cycle[(e)]	5.7×10^6
Combination Alternative[(f)]	5.4×10^6

(a) Carbon dioxide equivalent (CO_{2eq}) is a metric used to compare the emissions of greenhouse gases (GHG) based on their global warming potential (GWP). The GWP is a measure used to compare how much heat a GHG traps in the atmosphere. The GWP is the total energy that a gas absorbs over a period of time compared to carbon dioxide. CO_{2eq} is obtained by multiplying the amount of the GHG by the associated GWP. For example, the GWP of methane is 21; therefore, 1 ton of methane emission is equivalent to 21 tons of carbon dioxide emissions.

(b) Greenhouse gas emissions include only direct emissions from combustion sources averaged over the 5-year-period presented in Table 4-6 (Source: FPL 2018f).

(c) Emissions resulting from activities at Turkey Point that would occur between plant shutdown and the beginning of decommissioning and assumed not to be greater than greenhouse gas emissions from operation of Turkey Point.

(d) Emissions assumed to be similar to Turkey Point operation.

(e) Emissions from direct combustion of natural gas. Greenhouse gas emissions estimated using emission factors developed by the DOE's National Energy Technology Laboratory (NETL 2012).

(f) Emissions from the natural gas combined-cycle component of the combination alternative. Greenhouse gas emissions estimated using emission factors developed by DOE's National Renewable Energy Laboratory (NETL 2012).

4.15.3.2 Climate Change

Observed Trends in Climate Change Indicators

Climate change is the decades or longer change in climate measurements (e.g., temperature and precipitation) that has been observed on a global, national, and regional level (IPCC 2007, EPA 2016b, USGCRP 2014). Climate change can vary regionally, spatially, and seasonally, depending on local, regional, and global factors. Just as regional climate differs throughout the world, the impacts of climate change can vary among locations.

On a global level, from 1901 to 2015, average surface temperatures rose at a rate of 0.15 ˚F (0.08 ˚C) per decade, and total annual precipitation increased at an average rate of 0.08 inches (0.2 cm) per decade (EPA 2016b). The years 2017 and 2018 were the second and fourth warmest, respectively, on record globally; 2016 remains the warmest year on record. This finding is based on average global temperature data dating back to 1880. Analyses performed by both the National Aeronautics and Space Administration (NASA) and NOAA show that globally, the last 5 years have been the warmest in the modern record (NASA 2018, 2019). The observed global change in average surface temperature and precipitation has been accompanied by an increase in sea surface temperatures, a decrease in global glacier ice, an increase in sea level, and changes in extreme weather events. Such extreme events include an increase in the frequency of heat waves, very heavy precipitation (defined as the heaviest 1 percent of all daily events), and recorded maximum daily high temperatures (IPCC 2007, EPA 2016b, USGCRP 2009, USGCRP 2014).

The U.S. Global Change Research Program (USGCRP) compiles the best available information and maintains the current state of knowledge regarding climate change trends and effects at the regional and national level. The USGCRP reports that, from 1901 to 2016, average surface temperature has increased by 1.8 °F (1.0 °C) across the contiguous United States. Since 1901, average annual precipitation has increased by 4 percent, comprised of increases in the Northeast, Midwest, and Great Plains and decreases across parts of the Southwest and Southeast (USGCRP 2017, 2018: Fig 2.5). On a seasonal basis, warming has been the greatest in winter. Since the 1980s, NOAA data show an increase in the length of the frost-free season, the period between the last occurrence of 32 ˚F (0 °C) in the spring and first occurrence of 32 ˚F (0 °C) in the fall, across the contiguous United States. Over the period 1991 through 2011, the average frost-free season was 10 days longer than between 1901 and 1960 (USGCRP 2014). Over the past two decades, the number of high temperature records observed in the United States far exceeds the number of low temperature records (USGCRP 2018).

Observed climate change-related indicators across the United States include increases in the frequency and intensity of heavy precipitation, earlier onset of spring snowmelt and runoff, rise of sea level in coastal areas, increase in occurrence of heat waves, and a decrease in occurrence of cold waves. Since the 1980s, the intensity, frequency, and duration of North Atlantic hurricanes has increased; however, there is no trend in landfall frequency along the U.S. eastern and Gulf coasts (USGCRP 2014).

Warming has generally been uneven across the Southeast region of the United States, where Turkey Point is located (USGCRP 2017, 2018). The Southeast region of the United States is one of the few areas of the world where there has not been an overall increase in daily maximum temperatures since 1900 (NOAA 2013a, USGCRP 2018). Across the Southeast, annual average temperatures have warmed by less than 0.5 °F (0.28 °C) (USGCRP 2014, 2017). The overall lack of warming in the Southeast has been termed “the warming hole” (NOAA 2013a, NOAA 2013b, USGCRP 2017). However, since the 1970s, average annual temperatures have steadily increased across the Southeast and have been accompanied by an increase in the number of hot days with maximum temperatures above 95 °F (35 °C) in the daytime and above 75 °F (23.9 °C) in the nighttime (NOAA 2013a, USGCRP 2009, USGCRP 2014, USGCRP 2018: Fig 19.1). The average annual number of hot days observed since the 1960s remains lower than the average number during the first half of the 20th century. In contrast, the number of warm nights above 75 °F (23.9 °C) has doubled on average in the Southeast region compared to the first half of the 20th century and have increased at most observing stations (USGCRP 2018: Fig 19.1). The eastern and far southern portions of the region have experienced a more definitive warming trend since 1901 (EPA 2016b, EPA 2016c, USGCRP 2018: Fig 2.4). South Florida has warmed by greater than 1.5 °F (0.83 °C) over the period 1986-2016 (relative to 1901-1960 for the contiguous United States) (EPA 2016c, USGCRP 2014: Fig 2.7, USGCRP 2018: Fig 2.4).

Average annual precipitation data for the Southeast does not exhibit an increasing or decreasing trend for the long-term period (1895–2011) (NOAA 2013b). Precipitation in the Southeast region varies considerably throughout the seasons and average precipitation has generally increased in the fall and decreased in the summer (NOAA 2013b, USGCRP 2009). Across parts of the Southeast region, including parts of Florida, decreases in annual average precipitation of up to 10 percent have occurred over the period 1986–2015 (relative to 1901-1960 for the contiguous United States) (USGCRP 2018: Fig 2.5). Changes in the frequency and intensity of heavy precipitation events across the United States have been more definitive. Between 1958 and 2016, heavy precipitation (i.e., the amount of annual precipitation falling in the heaviest 1 percent of events) has increased by an average of 27 percent across the Southeast region (USGCRP 2018: Fig 2.6).

Specific to South Florida, the NRC staff used the NOAA Climate at a Glance tool to analyze temperature and precipitation trends for the period of 1895 to 2018 in the lower east coast region of Florida (NOAA 2018b). A trends analysis shows that average annual temperature has increased at a rate of 0.2 °F (0.11 °C) per decade while average annual precipitation has remained relatively flat with large year-to-year variations (NOAA 2018b). The number of extreme precipitation events (defined as precipitation greater than 4 inches, averaged over 5-year periods) since 1900 has been highly variable for Florida with no clear trend. In contrast, the threat of drought is persistent across the State, and Florida has experienced below average precipitation over the last decade (2005–2014) (Runkle et al. 2017).

Based on an analysis of tidal gauge data, global mean sea level has risen by approximately 8 to 9 inches (20 to 23 cm) since 1880, with about 3 inches (7.6 cm) of the rise having occurred since 1993. Since the early 1990s, tidal gauge and satellite altimeter data indicate an acceleration in the rate of sea level rise, which is now on the order of 1.2 inches (3 cm) per decade. With higher sea levels, the frequency of tidal flooding that causes minor impacts or "nuisance floods" has increased by a factor of 5 to 10 since the 1960s in several United States coastal cities. The rates of increase in such flooding are accelerating in more than 25 cities along the Atlantic and Gulf Coasts (USGCRP 2017).

Observed changes in sea level and their effects vary regionally and locally. In the United States, the Mid-Atlantic and parts of the Gulf coasts have experienced the greatest sea level rise, with some stations having experienced increases of more than 8 in. (20 cm) between 1960 and 2015 (EPA 2016b). Currently, the relative sea level rise trend at Miami, FL is 0.09 in. per year (0.24 cm per year), or about 9 in. (23 cm) per century. This is based on NOAA tidal gauge readings and includes local vertical land motion (e.g., subsidence and/or uplift) (NOAA 2018c).

Climate Change Projections

Future global greenhouse gas emission concentrations (emission scenarios) and climate models are commonly used to project possible climate change. Climate models indicate that over the next few decades, temperature increases will continue due to current greenhouse gas emission concentrations in the atmosphere (USGCRP 2014, 2018). Over the longer term, the magnitude of temperature increases and climate change effects will depend on both past and future global greenhouse gas emissions (IPCC 2007, IPCC 2013, USGCRP 2009, USGCRP 2014, USGCRP 2018). Climate model simulations often use greenhouse gas emission scenarios to represent possible future social, economic, technological, and demographic development that, in turn, drive future emissions. Consequently, the greenhouse gas emission scenarios, their supporting assumptions, and the projections of possible climate change effects entail substantial uncertainty.

The Intergovernmental Panel on Climate Change has generated various representative concentration pathway (RCP) scenarios commonly used by climate-modeling groups to project future climate conditions (IPCC 2000, IPCC 2013, USGCRP 2017, USGCRP 2018). For instance, the A2 scenario is representative of a high-emission scenario in which greenhouse gas emissions continue to rise during the 21st century from 40 gigatons (GT) of carbon dioxide equivalents (CO_{2eq}) per year in 2000 to 140 GT of CO_{2eq} per year by 2100. The B1 scenario, on the other hand, is representative of a low-emission scenario in which emissions rise from 40 GT of CO_{2eq} per year in 2000 to 50 GT of CO_{2eq} per year midcentury before falling to 30 GT of CO_{2eq} per year by 2100 (IPCC 2000, USGCRP 2014).

The RCP scenarios are based on predicted changes in radiative forcing (a measure of the influence that a factor, such as greenhouse gas emissions, has in changing the global balance of incoming and outgoing energy) in the year 2100 relative to preindustrial conditions. The RCPs are numbered in accordance with the change in radiative forcing measured in watts per square meter (i.e., +2.6 (very low), +4.5 (lower), +6.0 (mid-high) and +8.5 (higher)) (USGCRP 2014, 2017, 2018). For example, RCP 8.5 reflects a continued increase in global emissions resulting in increased warming by 2100, while RCP 2.6 assumes immediate and rapid reductions in emissions resulting in less warming by 2100 (USGCRP 2014). Most recently, the USGCRP and the Intergovernmental Panel on Climate Change have used the RCPs and associated modelling results as the basis of its climate change assessments (IPCC 2013, USGCRP 2017, 2018).

The NRC staff considered the best available national climate change studies as part of its assessment of potential changes in climate-relevant indicators during the Turkey Point subsequent license renewal term (2032–2052 and 2033–2053 for Units 3 and 4, respectively). As input to the Third National Climate Assessment report (USGCRP 2014), NOAA analyzed future regional climate change scenarios based on climate model simulations using the high (A2) and low (B1) emission scenarios. NOAA's climate model simulations (for the period between 2041 and 2070 (2055 midpoint) relative to the reference period, 1971–1999) indicate the following. Annual mean temperature is projected to increase by 1.5–3.5 °F (0.83–1.9 °C) across the Southeast region under the low-emission modeled scenario, with much of the Florida peninsula falling in the lower end of the range. For the high-emission-modeled scenario, projected temperature increases fall within the range of 2.5–4.5 °F (1.4–2.5 °C), again with much of Florida experiencing warming on the low end of the range (NOAA 2013a: Fig 26). Increases in temperature during this time period are projected to occur for all seasons with the largest increase occurring in the summertime (June, July, and August) (NOAA 2013a: Fig 27).

Newer regional projections for annual mean temperature are available from The Fourth National Climate Assessment based on the RCP 4.5 and RCP 8.5 scenarios for the mid-century (2036-2065) as compared to the average for 1976-2005. The modeling predicts increases of 3.4–4.3 °F (1.9–2.4 °C) across the Southeast region by mid-century (USGCRP 2017: Tab 6.4). For much of the Florida peninsula, predicted annual temperature increases range from 2–4 °F (1.1–2.2 °C) under both scenarios (USGCRP 2017: Fig 6.7).

As for precipitation, the climate model simulations (for the time period 2041–2070, 2055 midpoint) suggest spatial differences in annual mean precipitation change across the Southeast with some areas experiencing an increase and others a decrease in precipitation. On a seasonal basis, climate models are not in agreement on the sign or direction (increase or decrease) of modeled precipitation changes. For Florida, a 0 to 3 percent decrease in annual mean precipitation is predicted under both a low- and high-emission-modeled scenario; however, the predicted changes in precipitation are not significant as the models indicate changes that are less than normal year-to-year variations (NOAA 2013a: Fig 37).

Heavy precipitation events across the Southeast including Southern Florida are expected to increase in both frequency and intensity. The USGCRP predicts continued increases in the frequency and intensity of heavy or extreme precipitation events across the United States, including across the Southeast region (USGCRP 2014, USGCRP 2017, USGCRP 2018). For the Southeast region, models predict a 9 percent average increase in extreme precipitation (representing change in the 20-year return period amount for daily precipitation) under the lower RCP 4.5 scenario and up to 12 percent under the higher RCP 8.5 scenario by mid-century (USGCRP 2017: Fig 7.7).

With a warming climate, model simulations indicate that the total number of tropical storms will either remain steady or decrease worldwide. However, projections show that the frequency of the most intense storms will increase, and rainfall will be more intense with a given storm (USGCRP 2018). Climate models are not in agreement when projecting changes in Atlantic hurricane activity; nonetheless, models agree that under a warmer climate, hurricane-associated rainfall rates and wind speed will increase (EPA 2016b, USGCRP 2014, 2018).

In 2017, the USGCRP issued its Fourth National Climate Assessment report (USGCRP 2017), which includes updated sea level rise projections. The 2017 report updates NOAA's global sea level rise scenarios presented in the report, "Global Sea Level Rise Scenarios for the United States National Climate Assessment" (Parris et al. 2012) and which were previously used as the basis of the Southeast Florida Regional Climate Change Compact's 2015 sea level projections.

As for future sea levels, the USGCRP reports that, relative to the year 2000, global mean sea level is projected rise by 0.3 to 0.6 feet (0.09 to 0.18 m) by 2030 and 0.5 to 1.2 feet (0.15 to 0.37 m) by 2050 (USGCRP 2017). The USGCRP assigns very high confidence to the lower bounds of these projections and medium confidence to the upper bounds. For the first half of this century, future greenhouse gas emissions will have little effect as sea levels continue to rise, but emissions significantly affect levels beyond mid-century. Relative sea level rise on the East and Gulf Coasts of the United States is likely to be higher than the global average (USGCRP 2017, 2018).

Beyond the 2050 timeframe (and beyond the subsequent license renewal term for Turkey Point Units 3 and 4) and to the end of the century, sea levels are projected to continue to rise but the projections are subject to even greater uncertainty. In Appendix I, Section I.2 of the final EIS for the proposed Turkey Point Units 6 and 7 combined licenses (NUREG–2176, NRC 2016a), the NRC staff cited earlier sea level rise projections from the USGCRP (USGCRP 2014) of 1 to 4 feet (0.3 to 1.2 m) globally by the year 2100. NUREG-2176 also cited the "extreme high end" sea level rise estimate of 8.2 feet (2.5 m) by the year 2100 (NRC 2016a). In NUREG-2176, the NRC staff conjectured that should such a high rate of sea level rise occur, "much of South Florida would be uninhabitable and millions of people would likely be displaced." However, the NRC staff also observed that because sea level rise is likely to continue gradually, adaptation is possible (NRC 2016a). The latest consensus estimates from the USGCRP similarly indicate potential global sea level rise of 1 to 4.3 feet (0.3 to 1.3 m) by 2100. The USGCRP assigns low confidence to the upper bounds estimates for the year 2100 in part because future greenhouse gas emissions drive sea level rise projections for the second half of the century (USGCRP 2017, 2018). The USGCRP also indicates that sea level rise of 8 feet (2.4 m) or higher is physically possible, although the probability of that occurring has not been assessed by the USGCRP to date (USGCRP 2017, 2018). Nevertheless, it is apparent that future sea level rise is difficult to predict and is dependent on the amount of warming, ice melt from glaciers and ice sheets, and vertical land motion (e.g., local land subsidence or uplift) that may occur (USGCRP 2014, USGCRP 2017).

In 2015, the Southeast Florida Regional Climate Change Compact (SFRCCC or the Compact) published its update to the unified sea level rise projection. Its projections are intended for use by counties in the Southeast Florida compact to support planning with respect to potential vulnerabilities and the development of mitigation strategies to sea level rise (SFRCCC 2015).

The Compact produced sea level rise projections for three planning horizons (2030, 2060, and 2100). The projections for the medium term (i.e., 2060) most closely approximate the USGCRP's 2050 projections, which encompass the subsequent license renewal term for Turkey Point. Based on the Compact's estimates, relative to the year 1992, mean sea levels would rise 0.5 to 0.83 feet (0.15 to 0.25 m) by 2030 and 1.16 to 2.83 feet (0.35 to 0.86 m) by 2060. These estimates are referenced to the tidal gauge at Key West, FL. The Compact's projections (SFRCCC 2015), which are given in inches, have been converted to feet here for ease of comparison with those from the USGCRP (USGCRP 2017).

The NRC staff observes that in the short term (i.e., by the year 2030, or prior to the subsequent license renewal term), the Compact's regional estimates are not substantially different from the latest estimates produced by the USGCRP, although they diverge in the medium term (2050 to 2060). Specifically, the USGCRP projects sea level rise of 0.5 to 1.2 feet (0.15 to 0.37 m) by 2050, while the Compact projects a sea level rise of 1.16 to 2.83 feet (0.35 to 0.86 m) by 2060. The NRC staff observes that such divergence is not unexpected as uncertainty in the projections also increases with time. The Compact acknowledges as much, stating that, "sea level rise in the medium and long term has a significant range of variation as a result of uncertainty in future greenhouse gas emissions and their geophysical effects" (SFRCCC 2015).

The Compact's sea level rise estimates have some inherent differences as compared to the consensus-based estimates from the USGCRP. For example, the USGCRP's sea level rise estimates are relative to global mean sea level while the Compact's estimates are referenced to mean sea level at Key West, FL. The temporal baseline from which incremental sea level is measured also varies (year 2000 for USGCRP's current estimates versus 1992 for the Compact), a difference of 8 years over which time some sea level rise has inevitably already occurred. Accordingly, while they are useful for future planning, the various estimates are not directly comparable.

Based on the NRC staff's review, the staff considers the Compact's estimates to be conservative or bounding estimates (i.e., they reflect a higher sea level rise than would likely be observed based on the best available data from the USGCRP). As described in the Compact (SFRCCC 2015), sea level rise range estimates are based on the more conservative sea level rise projections or "curves" prepared by NOAA, the USACE, and the Intergovernmental Panel on Climate Change. Specifically, the Compact cites as the basis of its projections what is describes as the "NOAA high curve," the "USACE high curve," and the median of the IPCC Fifth Assessment Report's (AR5) RCP 8.5 scenario, which is described in the report, "Climate Change 2013: The Physical Science Basis" (IPCC 2013). These scenarios in part define the upper bound (e.g., up to 2.83 feet (0.86 m) in sea level rise by 2060) of the Compact's projections.

The NOAA high curve adopted by the Compact is derived from the highest of four global sea level rise scenarios (i.e., highest, intermediate-high, intermediate-low, and lowest) presented in NOAA Technical Report OAR CPO-1 (Parris et al. 2012). As stated by Parris et al. (Parris et al. 2012), the highest scenario, in part, assumes "the maximum possible glacier and ice sheet loss." Similarly, with regard to the USACE high curve, USACE Technical Letter No. 1100-2-1 (DOA 2014) indicates that the USACE high curve exceeds the upper boundaries for projected sea level rise from the Intergovernmental Panel on Climate Change for 2001, 2007, and 2013. The curve further accounts for the possibility of rapid ice loss from Antarctica and Greenland, and generally falls between the highest and intermediate high curves given in Parris (Parris et al. 2012). Finally, the Compact's adoption of RCP 8.5 represents another rather conservative assumption. As noted in the USGCRP report (USGCRP 2017), the RCP 8.5 scenario in part assumes that global carbon emissions continue to rise steadily due to continued fossil fuel combustion, whereas other scenarios reflect varying reductions in emissions.

Based on the studies referenced above, it is apparent that rising sea levels will continue to have measurable hydrologic effects on coastal communities, but those effects may vary in severity on a local and regional basis. As sea levels rise, the incidence of tidal flooding in coastal areas due to all coastal storms will increase, as will the depth and extent of such flooding (USGCRP 2017, 2018). Further, the USGCRP reports that there is medium confidence that the intensity of North Atlantic hurricanes will increase, thus increasing the chances of extreme flooding along the East and Gulf Coasts. However, as noted above, there is less confidence in the projected increase in frequency of intense storms including Atlantic hurricanes (USGCRP 2017, 2018). Modeling also suggests that predicted changes in the tracks of tropical cyclones may reduce hurricane landfalls along the Northeast and Mid-Atlantic coasts of the United States (USGCRP 2018).

Changes in climate have broader implications for public health, water resources, land use and development, and ecosystems. For instance, changes in precipitation patterns and increases in air temperature can affect water availability and quality, distribution of plant and animal species, land use patterns, and land cover, which can, in turn, affect terrestrial and aquatic habitats. In Section 4.16 of this SEIS, the NRC staff considers the potential cumulative, or overlapping, impacts from climate change on environmental resources that could also be impacted by the proposed action (subsequent license renewal).

The effects of climate change on Turkey Point Unit 3 and 4 structures, systems, and components are outside the scope of the NRC staff's license renewal environmental review. The environmental review documents the potential effects from continued nuclear power plant operation on the environment. Site-specific environmental conditions are considered when siting nuclear power plants. This includes the consideration of meteorological and hydrologic siting criteria as set forth in 10 CFR Part 100, "Reactor Site Criteria." Turkey Point was designed and constructed in accordance with 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants." NRC regulations require that plant structures, systems, and components important to safety be designed to withstand the effects of natural phenomena, such as flooding, without loss of capability to perform safety functions. Further, nuclear power plants are required to operate within technical safety specifications in accordance with the NRC operating license, including coping with natural phenomena hazards. The NRC conducts safety reviews prior to allowing licensees to make operational changes due to changing environmental conditions. Additionally, the NRC evaluates nuclear power plant operating conditions and physical infrastructure to ensure ongoing safe operations under the plant's initial and renewed operating licenses, through the NRC's reactor oversight program. If new information about changing environmental conditions (such as rising sea levels that threaten safe operating conditions or challenge compliance with the plant's technical specifications) becomes available, the NRC will evaluate the new information to determine if any safety-related changes are needed at licensed nuclear power plants.

As part of the NRC's subsequent license renewal review for Turkey Point Units 3 and 4, a safety review was conducted. The NRC staff issued its initial safety evaluation report in May 2019 (NRC 2019l), and a final safety evaluation report in July 2019. While the NRC's safety review does not include a flood analysis of Turkey Point Units 3 and 4 or for the CCS in particular, it does document a requirement that FPL develop and implement an aging management program for the CCS as related to water-control structures, the failure of which could impact safety-related equipment. Aging management programs are implemented at the beginning of a new licensing period. FPL has stated in its license renewal application that the aging management program for the CCS will be commensurate with Regulatory Guide 1.12, "Criteria and Design Features for Inspection of Water-Control Structures Associated with Nuclear Power Plants" (NRC 2016e). The aging management program proposed by FPL specific to the CCS will include:

1) Visual inspections performed at least once every 5 years.
2) Special inspections will be performed following major events such as hurricanes.
3) Photographs will be used to document findings and trend degradation.
4) The inspections will be consistent with the 10 elements of NUREG-2191, Section XI.S7. "Inspection of Water-Control Structures Associated with Nuclear Power Plants" (NRC 2017c).
5) Parameters monitored for the CCS will be enhanced to include erosion and degradation.

In addition, as described above in Section 3.5.1.3, FPL's draft NPDES permit for the Turkey Point site issued by FDEP includes requirements for impoundment design, construction, operation, and maintenance. While the NRC aging management program is concerned with the safe operation of Units 3 and 4, the requirements of the NPDES permit address potential impacts on the environment from a structural failure of the CCS.

Based on the requirements of both the NRC's aging management program and the State-issued NPDES permit, the NRC staff has determined that the NRC's oversight process would monitor the structural integrity of the CCS over the duration of the subsequent license renewal term, and the FDEP's NPDES permit requirements will ensure that the CCS is monitored for any degradation that may lead to environmental impacts. FPL is required to report degradation of the CCS to State regulatory agencies to ensure that timely remedial actions can be taken.

As described above, ensuring continued safe operation of an operating nuclear power plant is a separate and distinct process from the NRC staff's subsequent license renewal environmental review that the staff conducts in accordance with the National Environmental Policy Act (NEPA). Nonetheless, as discussed below, the NRC staff considers the impacts of climate change in combination with the effects of subsequent license renewal, in assessing cumulative impacts on environmental resources in Section 4.16 of this SEIS.

4.16 Cumulative Impacts

Cumulative impacts may result when the environmental effects associated with the proposed action (e.g., subsequent license renewal) are added to the environmental effects from other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time. An effect that may be inconsequential by itself could result in a greater environmental impact when combined with the effects of other actions. As explained in NUREG-1437, "Generic

Environmental Impact Statement for License Renewal of Nuclear Plants" (the GEIS) (NRC 2013a), the effects of the license renewal action combined with the effects of other actions could generate cumulative impacts on a given resource.

For the purposes of this analysis, past actions are those that occurred since the commencement of Turkey Point Units 3 and 4 reactor operations and prior to the submittal of the license renewal application. Older actions are considered as part of the affected environment in Chapter 3 of this SEIS. Present actions are those that are occurring during current power plant operations. Future actions are those that are reasonably foreseeable to occur through the end of power plant operation, including the period of extended operation. Therefore, the cumulative impacts analysis considers potential effects through the end of the current license term, as well as through the end of the 20-year subsequent license renewal term.

The cumulative impacts analysis accounts for both geographic (spatial) and time (temporal) considerations of past, present, and reasonably foreseeable future actions to determine whether other potential actions are likely to contribute to the total environmental impact. In addition, because cumulative impacts accrue to resources and focus on overlapping impacts with the proposed action, no cumulative impacts analysis was performed for resource areas where the proposed action is unlikely to have any incremental impacts on that resource. For example, because FPL is prohibited from discharging effluents into surface waters of the State and because impacts to surface water bodies via the groundwater pathway are projected to be SMALL during the subsequent license renewal period, subsequent license renewal is not expected to have a cumulative impact on surface water quality. Consequently, no cumulative impacts analysis was performed for the following resource areas: land use, noise, surface water, and geology and soils.

As noted in Section 4.15.3.2, "Climate Change," of this SEIS, changes in climate could have broad implications for certain resource areas. Accordingly, a climate change impact discussion is provided for those resource areas that could be incrementally impacted by the proposed action (subsequent license renewal). It is also important to note that the potential effects of climate change would occur irrespective of the proposed action.

Information from FPL's environmental report; responses to requests for additional information; information from other Federal, State, and local government agencies; scoping comments; and information gathered during the NRC staff's visit to Turkey Point were used to identify past, present, and reasonably foreseeable future actions in the cumulative impacts analysis. To evaluate cumulative impacts resulting from the continued operation of Turkey Point Units 3 and 4, the incremental impacts of the proposed action, as described in Sections 4.2 to 4.13 of this SEIS, are combined with the impacts of other past, present, and reasonably foreseeable future actions regardless of which agency (Federal or non-Federal) or person undertakes such actions. In general, the effects of past actions have already been described in Chapter 3 of this SEIS, the affected environment, which serves as the environmental baseline for the cumulative impacts analysis.

Chapter 7.0 of the NRC staff's EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG-2176) (NRC 2016a) provides a recent analysis of cumulative impacts at the Turkey Point site resulting from the construction and operation Turkey Point Units 6 and 7. Table 7-1 in NUREG-2176 identifies the past, present, and reasonably foreseeable future actions and other actions near the Turkey Point site, including Everglades restoration, and other energy, mining, and transportation projects considered in the analysis. All of this information is incorporated here by reference (NRC 2016a: pages 7-1 through 7-46).

The NRC staff identified as an additional future action, a plan that SDI Aggregate, LLC, a private project located at a quarry approximately 5.5 mi (9 km) west of Turkey Point, has to install a series of injection wells to mitigate the progression of saltwater intrusion westward. The SFWMD issued a consumptive use permit for this project in 2017 (SFWMD 2017a).

In addition, two potential future actions at the Turkey Point site were identified during the subsequent license renewal review: (1) the possible construction and operation of a Miami-Dade County wastewater treatment facility and (2) the possible expansion of the Turkey Point Units 3 and 4 independent spent fuel storage installation (ISFSI). FPL and Miami-Dade County have agreed to investigate the potential to create a tertiary wastewater treatment facility that could provide up to 60 million gallons (approximately 230 million liters) per day of reclaimed wastewater for use at the Turkey Point site. Possible uses for this treated wastewater would include makeup water for Turkey Point Unit 5 forced draft cooling towers and freshening water to assist in managing salinity in the cooling canal system (CCS). If constructed, this tertiary wastewater treatment facility could provide reclaimed water to the CCS during the subsequent license renewal period of extended operations. To date, FPL and Miami-Dade County have not yet committed to building this facility.

FPL may also need to expand the Turkey Point Units 3 and 4 ISFSI, which could require the construction of a new ISFSI pad to accommodate additional spent nuclear fuel generated during the subsequent license renewal term, if DOE does not begin to take ownership of the spent nuclear fuel in 2031 (FPL 2018g). Conversely, FPL may choose to utilize a higher density storage system to create additional storage capacity, thereby reducing the need to expand the ISFSI. As a result, FPL has not yet determined whether it would expand the ISFSI.

Regardless, if implemented, each of these actions would likely be completed prior to the commencement of the subsequent license renewal term. No other new and significant information was identified during the NRC staff's review of FPL's environmental report for Turkey Point Units 3 and 4 (FPL 2018f), the site audit, the scoping process, or the evaluation of other available information since the Turkey Point Units 6 and 7 COL EIS was issued (NUREG 2176) (NRC 2016a).

4.16.1 Air Quality

The region of influence (ROI) that the NRC staff considered in the cumulative air quality analysis is Miami-Dade County because air quality designations in Florida are made at the county level. FPL has not proposed any refurbishment-related activities during the subsequent license renewal period. As a result, the NRC staff expects that air emissions at Turkey Point during the subsequent license renewal period would be similar to those presented in Section 3.3.2, "Air Quality." Table 7-1 of the NRC staff's EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG-2176) (NRC 2016a), which is incorporated by reference in Section 4-16 of this SEIS, provides a list of present and reasonably foreseeable future projects that could contribute to cumulative impacts to air quality in Miami-Dade County. Current air emission sources operating in Miami-Dade County have not resulted in long-term National Ambient Air Quality Standards (NAAQS) violations given the designated unclassifiable/attainment status for all NAAQS in Miami-Dade County. Consequently, cumulative changes to air quality in Miami-Dade County would be the result of future projects and actions that change present-day emissions within the county.

The development and construction activities identified above in Section 4.16 and those identified in Table 7-1 of the EIS for the Turkey Point Units 6 and 7 combined licenses

(NUREG-2176) (NRC 2016a) can increase air emissions during their respective construction periods, but those air emissions would be temporary and localized. However, future operation of new commercial and industrial facilities and increases in vehicular traffic can result in overall long-term air emissions that contribute to cumulative air quality impacts. Any entity establishing new stationary sources of emissions in the region of influence would be required to apply for an air permit from the FDEP and would also be required to operate in accordance with applicable Federal, State, and local regulatory requirements.

Climate Change

Climate change can impact air quality as a result of changes in meteorological conditions. The formation, transport, dispersion, and deposition of air pollutants depend, in part, on weather conditions (IPCC 2007). Ozone has been found to be particularly sensitive to climate change (IPCC 2007; EPA 2009a). Ozone is formed, in part, as a result of the chemical reaction of nitrogen oxides and volatile organic compounds in the presence of heat and sunlight. Sunshine, high temperatures, and air stagnation are favorable meteorological conditions for higher levels of ozone (IPCC 2007, EPA 2009b). The emission of ozone precursors also depends on temperature, wind, and solar radiation (IPCC 2007). According to the EPA, both nitrogen oxide and biogenic volatile organic compound emissions are expected to be higher in a warmer climate (EPA 2009a). Although surface temperatures are expected to increase in the Southeast region of the United States (where Turkey Point is located), this may not necessarily result in an increase in ozone concentrations (Diem et al. 2017). For instance, during the fall in the Southeast, ozone concentrations correlate with humidity (Zhang and Wang 2016). Wu et al. (Wu et al. 2008) modeled changes in ozone levels in response to climate change and found negligible climate change-driven ozone concentrations for the Southeast region. Tao et al. (Tao et al. 2007) found differences in future changes in ozone for the Southeast with decreases in ozone concentrations under a low-emission-modelled scenario and increase under a high-emission-modelled scenario. Among modelled studies of climate-related ozone changes, model simulations for the Southeast region have the least consensus. Therefore, the potential cumulative impact to air quality ozone levels in the vicinity of Turkey Point due to climate change is unknown.

4.16.2 Water Resources

4.16.2.1 Groundwater Resources

The description of the affected environment in Section 3.5.2, “Groundwater Resources,” of this SEIS serves as the baseline for the NRC staff’s cumulative impacts assessment for groundwater resources. For groundwater, the geographic area of interest is comprised of the local and regional aquifer systems potentially affected by Turkey Point operations, the surficial (i.e., Biscayne) and Floridan aquifer systems. As such, this review focuses on those projects and activities that would withdraw water from, or discharge effluents to, the referenced aquifer systems.

Water Use Considerations

As part of the NRC staff’s analysis for proposed Units 6 and 7, Sections 7.2.1.2, “Groundwater-Use Impacts,” and Appendix G, Section G.3.2.3, “Summary of Review Team Focused Modeling,” of the final EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG–2176, NRC 2016a: 7-13–7-14, G-46–G-48) evaluate the cumulative impacts on groundwater use. The analysis considered preconstruction, construction, and operations of proposed Units 6 and 7 as well as the other past, present, and reasonably foreseeable future actions that could affect groundwater uses, including some ongoing activities at the Turkey Point site and the potential continued operation of Turkey Point Units 3 and 4 through subsequent license renewal. In summary, the NRC staff concluded the following:

- The impacts from NRC-authorized construction from Units 6 and 7 and operations from Units 3, 4, 5, and 6 on groundwater use would be SMALL, and no further mitigation would be warranted beyond the State of Florida Siting Board's final conditions of certification (State of Florida Siting Board 2014).
- Limited operation of the four proposed radial collection wells at a withdrawal rate of 120 mgd (454,000 m^3/day) on the Turkey Point peninsula would have minor impacts on Biscayne aquifer users, although continued development and increased groundwater use could lower groundwater levels in the aquifer and cause further inland movement of the saltwater interface.
- There would be an increase in hydraulic head beneath the CCS associated with the addition of groundwater to the CCS for freshening with operation of recovery wells. Operation of hypersaline plume recovery wells could locally decrease heads in the aquifer. Radial collection well operation for Units 6 and 7 would result in minor localized alterations in salinity distribution.

The NRC staff incorporates here by reference these findings from the EIS for the Turkey Point Units 6 and 7 combined licenses (NRC 2016a: 7-13–7-14, G46–G-48).

Section 4.5.1.2 of this SEIS, "Conflicts Analysis for the Upper Floridan Aquifer," separately describes and evaluates the potential impacts of FPL's withdrawals from the Upper Floridan aquifer. FPL is authorized to withdraw 14.06 mgd (53,200 m^3/day) of groundwater from the upper production zones of the Upper Floridan aquifer for cooling water for Turkey Point Unit 5 and process water for Units 1, 2, 3, 4, and 5 (i.e., from three site production wells). FPL is authorized to withdraw an additional 14 mgd (53,000 m^3/day) from the freshening well system (i.e., wells F-1, F-3, F-4, F-5, F-6). These withdrawals are authorized under the modified site certification and associated conditions of certification for the Turkey Point site (State of Florida Siting Board 2016, FDEP 2016b). FPL commissioned Tetra Tech, a consulting and engineering services firm, to prepare a technical evaluation and associated groundwater flow model (Tetra Tech 2014b) to evaluate the proposed freshening withdrawals from the Upper Floridan aquifer to support FPL's 2014 site certification modification for Turkey Point (FPL 2018n).

The technical evaluation and results indicate that operation of the freshening well system at the maximum rate of 14 mgd (53,000 m^3/d) could result in maximum, offsite drawdowns of up to 2.26 feet (0.7 m) at the Miami-Dade Water and Sewer Department's (MDWSD's) South Miami Heights wellfield, located approximately 10.3 mi (16.6 km) north, northwest of the center point of FPL's freshening well system. Further, modeling shows that the incremental drawdown from freshening well system operations could account for 5 percent to as much as 19 percent of the total predicted cumulative drawdown from all permitted withdrawals from the Upper Florida aquifer at offsite locations. Specifically, the modeling projects incremental drawdown of up to 2.21 feet (0.67 m) at Sound Golf Club and Ocean Reef Club (about 9 mi (14 km) south of the FPL freshening wells); these drawdowns account for 19 percent of the total cumulative drawdown at these locations (Tetra Tech 2014b).

While the reported modeling results reflect conservative, bounding-case impacts, the results nonetheless indicate the potential for measurable cumulative impacts on groundwater within the

Upper Floridan aquifer. However, the NRC staff finds that the magnitude of FPL's withdrawals and projected cumulative drawdowns would be unlikely to preclude aquifer availability and cause groundwater use conflicts for other users based on the aquifer yields, total thickness, and regional extent, under current conditions. In addition, the State-issued modified site certification and associated conditions of certification for the Turkey Point site (State of Florida Siting Board 2016, FDEP 2016b) require FPL to mitigate harm to offsite groundwater users (either related to water quantity or quality) as well as to offsite water bodies, land uses, and other beneficial uses. As necessary, the SFWMD could require FPL to reduce withdrawals or undertake other mitigative actions during the subsequent license renewal term, as further described in Section 4.5.1.2 of this SEIS.

Implementation of the proposed project to treat up to 60 mgd (227,000 m^3/day) of sanitary wastewater from Miami-Dade County for use by FPL at the Turkey Point site would likely have net, beneficial cumulative impacts on groundwater use. Using treated sanitary wastewater in the CCS would potentially reduce or eliminate the need to operate FPL's freshening well system, which conveys artesian groundwater from the Upper Floridan aquifer into the CCS for salinity management. Any reduction in groundwater withdrawals from the Upper Floridan aquifer would reduce regional aquifer drawdown.

Operation of the proposed freshwater injection system at the limestone quarries located approximately 5 mi (8 km) west of the CCS and Turkey Point property would be likely to have net, beneficial cumulative impacts on groundwater use and quality. As proposed and permitted by SFWMD, the project would entail the withdrawal of up to 5 mgd (19,000 m^3/day) of fresh groundwater from a single well completed to a depth of 40 feet (12 m). This water would then be reinjected into the aquifer through a series of 14, 75-foot (23-m) deep injection wells that are aligned along the eastern edge of the quarry property. Reinjection of the groundwater is intended to form an eastward hydraulic barrier to protect the quarry property from encroachment of the regional saltwater interface (SFWMD 2017b). The system is also expected to contribute to efforts to retract the regional saltwater interface to the east, working in conjunction with FPL's recovery well system, as evaluated in Section 4.5.1.2 of this SEIS. The modeling performed by the project applicant and reviewed by SFWMD staff, as documented in its staff report, indicates that operation of the system would have minimal offsite drawdown in the Biscayne aquifer (SFWMD 2017b).

The NRC staff assumes that the freshwater injection system at the limestone quarries would continue at least as long as operation of FPL's recovery well system, since it is intended to work alongside FPL's recovery well system. As stated in Section 4.5.1.2 of this SEIS, current modeling projections indicate that FPL's recovery well system will be successful in retracting the hypersaline plume back to within the boundaries of the CCS within 10 years of startup (i.e., by about 2028) while also retracting the saltwater interface back to the east from its current location. If these projections are realized, then it is possible that neither the freshwater injection system project nor FPL's recovery well system will be operating by the start of Turkey Point's subsequent license renewal term (i.e., 2032 for Unit 3 and 2033 for Unit 4). In that case, neither activity would contribute to cumulative impacts associated with the proposed action (subsequent license renewal). Nonetheless, it is possible that FPL's recovery well system might remain in operation for as long as necessary to achieve and maintain compliance with applicable provisions under the 2015 Consent Agreement with Miami-Dade County DERM (MDC 2015a) and the 2016 Consent Order (FDEP 2016a) with FDEP.

Water Quality Considerations

In Section 7.2.2.2, “Groundwater-Quality Impacts,” of the final EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG–2176, NRC 2016a), the NRC staff presented its evaluation of the potential cumulative impacts on groundwater quality. The analysis considered preconstruction, construction, and operations of proposed Units 6 and 7 as well as the other past, present, and reasonably foreseeable future actions that could affect groundwater quality, including some ongoing activities at the Turkey Point site and the potential continued operation of Turkey Point Units 3 and 4. In summary, the NRC staff concluded the following:

- The impacts from NRC-authorized construction and operations on groundwater quality would be SMALL, and no further mitigation would be warranted beyond the State of Florida Siting Board’s final conditions of certification (State of Florida Siting Board 2014).
- Ongoing and future actions being undertaken by Federal, State, and local government agencies to enhance freshwater recharge of the Biscayne aquifer would potentially have a positive impact on groundwater quality by reducing the potential for westward movement of the saltwater interface.
- The addition of brackish water from the Upper Floridan aquifer to the CCS would be likely to lower temperature, salinity, and concentration of other constituents in the CCS; this would result in lower salt concentrations in water seeping out of the CCS and into the Biscayne aquifer and thus reduce impacts on the Biscayne aquifer.
- Deep well injection of wastewater into the Boulder Zone proposed for Units 6 and 7 combined with wastewater injection operations at the Miami-Dade South District Wastewater Treatment Plant would be unlikely to contribute to cumulative effects on groundwater quality in the Boulder Zone or result in degradation of groundwater quality in the overlying Upper Floridan aquifer.
- Mining operations in the region to support construction of Turkey Point Units 6 and 7 could affect groundwater quality by increasing salinity in underlying groundwater, but regulation of mining operations would ensure that cumulative impacts would be minor.

The NRC staff incorporates here by reference all of the above findings (NRC 2016a: 7-13, 7-16–7-18).

As previously described, the operation of FPL’s recovery well system is projected to be successful in retracting the hypersaline plume back to within the boundaries of the CCS within 10 years of startup (i.e., by about 2028) while also retracting the saltwater interface back to the east from its current location. This would result in beneficial impacts on groundwater quality within the Biscayne aquifer to the west of the CCS and the Turkey Point site as well as in the portions of the aquifer beneath Biscayne Bay affected by CCS operations. The NRC staff finds that it is reasonable to expect that FPL’s freshening well system would continue to be operated during the subsequent license renewal term, and for as long as necessary to maintain compliance with the terms of the 2015 Consent Agreement with Miami-Dade County DERM (MDC 2015a) and the 2016 FDEP Consent Order (FDEP 2016a). The continuation of CCS freshening (salinity management) activities would ensure that the average annual salinity of the CCS is maintained at or below 34 PSU, to control the generation and migration of a hypersaline plume in groundwater. The NRC staff expects that continued operation of the freshening system, combined with proper operation and maintenance of the CCS, will result in no substantial contribution to cumulative impacts on groundwater quality during the subsequent license renewal period.

Climate Change and Related Considerations

The NRC staff considered the best available information regarding the potential impacts of climate change at a regional and local scale, including the U.S. Global Change Research Program's (USGCRP's) most recent compilations of the state of knowledge relative to global climate change effects (USGCRP 2014, USGCRP 2017). In Appendix I, Section I.3.2 of the final EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG–2176, NRC 2016a), the NRC staff considered potential hydrologic changes related to climate change. Climate change can impact groundwater availability and quality as a result of changes in temperature and precipitation, as well as due to sea level rise.

As discussed in Section 4.15.3.2, "Climate Change," of this SEIS, average annual temperature across the lower east coast region of South Florida has increased at a rate of 0.2 °F (0.11 °C) per decade and is projected to continue to increase by up to 3.5 °F (1.9 °C) by 2050. Although annual precipitation data show no clear trend, climate model simulations indicate a slight decrease in annual mean precipitation by 2050. However, heavy precipitation events are expected to increase in both frequency and intensity. Changes in temperature and precipitation have important implications for near- or at-surface water table aquifers, such as the Biscayne aquifer of South Florida (see Section 3.5.2.1, "Hydrogeology and Aquifers," of this SEIS), which is locally recharged by precipitation and runoff and is the primary source of water supply for Miami-Dade County. An increase in average annual temperature without any increase in annual precipitation would likely increase evapotranspiration and reduce recharge to the Biscayne aquifer. Projected increases in heavy precipitation events could increase recharge during the timeframe when they occur. However, increases in heavy precipitation events and intensity without an annual increase in total precipitation would be unlikely to compensate for decreased recharge throughout the year.

The effects of climate change are projected to significantly increase water demand across most of the United States. Water demand across South Florida is projected to increase by more than 50 percent by 2060, relative to 2005, based on combined changes in population, socioeconomic conditions, and climate (NRC 2016a) (USGCRP 2014, Figure 3.11). For most of Florida, this increase in demand is forecast even without assuming climate change (USGCRP 2014, Figure 3.11). Regardless, climate change, mainly due to increases in temperature and evapotranspiration, would decrease water availability and further drive demand.

By about 2050, the USGCRP projects that global sea levels may rise by an additional 0.5 to 1.2 feet (0.15 to 0.37 m). This rise is likely to be higher along the East Coast of the United States (USGCRP 2017). Higher sea levels will increase the rate of saltwater intrusion (encroachment) into coastal freshwater supplies (USGCRP 2014). This is particularly true for the Biscayne aquifer, as referenced previously, but also for the confined, Upper Floridan aquifer, which is a designated underground source of drinking water across South Florida (see Sections 3.5.2.1 and 3.5.2.2 of this SEIS).

A rise in sea level would have the most direct impacts on the Biscayne aquifer. Currently, the saltwater interface is located about 4.7 mi (7.6 km) west of the Turkey Point site and the CCS at its closest point, as described in Sections 3.5.2.1 and 3.5.2.2 of this SEIS. As sea levels rise, saltwater from the east would move along the base of the Biscayne aquifer, pushing the saltwater interface farther to the west from its current location. Combined with sea level rise, decreases in recharge to the Biscayne aquifer would reduce the freshwater hydraulic head in the Biscayne aquifer, further increasing the potential for westerly migration of the saltwater interface across Miami-Dade County.

The potential for additional saltwater intrusion has significant implications for Miami-Dade County, other public water supply systems, and private and industrial users of the Biscayne and other affected aquifers. Increased salinity levels in groundwater supplies would increasingly require public and private groundwater users to invest in treatment technologies (e.g., desalination), to relocate supply wells and supporting infrastructure, to seek out and develop new water supply sources, or to pursue a combination of approaches to manage degraded groundwater quality.

In summary, increasing temperatures and steady or slightly decreasing average precipitation, combined with sea level rise, are expected to reduce groundwater recharge, degrade groundwater quality, and reduce water availability in southeastern Florida during the subsequent license renewal term. Therefore, climate change is expected to have adverse cumulative impacts on groundwater resources in the vicinity of Turkey Point.

4.16.3 Terrestrial Resources

The description of the affected environment in Section 3.6, "Terrestrial Resources," of this SEIS serves as the baseline for the NRC staff's cumulative impacts assessment for terrestrial resources. For terrestrial resources, the geographic area of interest is comprised of the Turkey Point site and offsite wetlands that could be impacted by FPL's efforts to recover and extract the hypersaline water within and around the CCS as described in Section 3.6.1, "Vegetative Communities."

In Section 7.3.1 of the EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG-2176, NRC 2016a), the NRC staff described the cumulative impacts that terrestrial resources on and near the Turkey Point site may experience. In its assessment, the staff considered the historical context of the region, including prior drainage, development, and other modifications within South Florida and the concomitant loss in species diversity and habitat. Present and reasonably foreseeable future activities considered in the analysis included urban development, energy production, mining, manufacturing, transportation and infrastructure development, and other miscellaneous activities that could affect terrestrial and wetland resources. The NRC staff (NRC 2016a) also considered current efforts to restore or improve ecological habitat, including the Comprehensive Everglades Restoration Program and the Southern Glades Addition. in addition, the NRC staff's cumulative impacts analysis (NRC 2016a) considered the overlapping impacts of construction and operation of proposed Turkey Point Units 6 and 7 with the impacts from continued operations at Units 3 and 4, such as any impacts to offsite wetlands from the removal of water from the L-31E Canal during periods of excess flow, for use in freshening the CCS. Appendix I, Section I.3.3 describes the potential overlapping impacts with climate change. The NRC staff incorporates here by reference the above cumulative impacts analyses from NUREG-2176 (NRC 2016a, Section 7.3.1, pages 7-19 to 7-23).

Since the NRC published the EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG-2176) (NRC 2016a), the NRC staff has determined that the possible construction and operation of a mine and a Miami-Dade County wastewater treatment facility, as well as the expansion of the Turkey Point Units 3 and 4 ISFSI, could result in additional overlapping impacts to wetlands and other important terrestrial resources. Construction could result in both the permanent and temporary loss of important terrestrial habitats, habitat fragmentation, and habitat degradation as a result of runoff, erosion, and sedimentation. Wildlife and birds would likely avoid the area during construction due to noise and other disturbances. Collisions with tall structures and vehicles could also result in mortality. However, the implementation of appropriate best management practices, revegetation following construction, and required compensatory mitigation for unavoidable wetland impacts would minimize such impacts. Furthermore, locating these projects within previously disturbed areas would minimize any potential impacts to important terrestrial habitats. FPL (2018g) determined that if Turkey Point requires a new ISFSI, the preferable candidate site would be located on previously disturbed land within or adjacent to the Units 3 and 4 protected area.

4.16.4 Aquatic Resources

The description of the affected environment in Section 3.7, "Aquatic Resources," in this SEIS serves as the baseline for the NRC staff's cumulative impacts assessment for aquatic resources. For aquatic resources, the geographic area of interest is comprised of the CCS and other surface waters on the Turkey Point site (i.e., the hypersaline mudflats, remnant canals, channels, dwarf mangrove wetlands, and open water areas described in Section 3.7.3, "Aquatic Resources on the Turkey Point Site") as well as Biscayne Bay. As such, this review focuses on those projects and activities that would affect the aquatic biota and habitats within this geographic area.

Many natural and human activities influence the characteristics of these aquatic environments and the condition of the aquatic resources found in them. In Section 4.7.1, "Proposed Action," the NRC staff concludes that impingement, entrainment, and thermal effects associated with the proposed subsequent license renewal would result in SMALL to MODERATE effects on the aquatic resources of the CCS. These effects would not apply to aquatic resources within Biscayne Bay because there are no surface water connections that allow aquatic organisms inhabiting the Bay to interact with Turkey Point's intake or discharge. All other potential impacts of subsequent license renewal on aquatic resources would be SMALL. In Section 7.3.2 of the EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG-2176), the NRC (2016a) staff considered a number of past, present, and reasonably foreseeable future actions whose effects could overlap, resulting in cumulative impacts on the aquatic resources on the Turkey Point site and within Biscayne Bay. In its analysis, the NRC staff evaluated the following cumulative effects, which the staff hereby incorporates by reference.

- Historical context of the region, including prior drainage, development, and other modifications within South Florida (pages 7-24 to 7-25)
- Existing units on the Turkey Point site (i.e., Units 1, 2, 3, 4, and 5) (pages 7-25 to 7-26)
- Ecological restoration initiatives and management programs, including the Model Lands Basin and Southern Glades Addition; the Biscayne Bay Park Fishery Management Plan; the Comprehensive Everglades Restoration Program; and Florida Keys National Marine Sanctuary (pages 7-26 to 7-28)
- Population growth and coastal development (pages 7-28 to 7-29)
- Future construction and operation of Turkey Point Units 6 and 7 (Section 4.3.2; summarized on pages 4-97 to 4-98)

The NRC staff considers the following additional actions below: the past and current operations of the CCS, the possible construction and operation of several new industrial facilities, and climate change.

Past and Current Operations of the CCS

The CCS supports the operation of Turkey Point Units 3 and 4 as well as Turkey Point Units 1 and 2. Although Units 1 and 2 no longer generate electricity, their use of the CCS as a cooling water source has contributed to the changes in the CCS over time. Currently, Units 1 and 2 circulate a small amount of water from the CCS to support synchronous condenser mode. However, because Units 1 and 2 no longer produce steam, they do not discharge heated water to the CCS. Section 3.1.3.2, "Cooling Canal System," of this SEIS contains a detailed description of the CCS and its operation. Section 3.5.1.4 of this SEIS describes water quality in the CCS and adjacent surface waters as well as the State-required monitoring and mitigation that FPL has undertaken or is in the process of undertaking. As described in these sections, the CCS began experiencing a visible ecosystem shift beginning in 2010 and CCS water quality has deteriorated over the past decade. The average salinity of the CCS has increased, water quality and clarity have degraded, and average surface water temperatures have increased. Seagrass colonies died off, and the subsequent decomposition of dead organic matter released a significant volume of nutrients into the CCS. This facilitated algae blooms, which resulted in high turbidity and further degraded water quality. Whereas the CCS had previously been a seagrass-based ecological system, it now operates as an algal-based, phosphorus-limited system such that the algae life cycle primarily dictates the movement of nutrients in and out of the water column. As discussed in Section 4.7.1.2, "Thermal Impacts on Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds)," a number of species of fish, mollusks, crabs, and seagrasses have disappeared from the CCS in recent years. Thermal stress is one factor that has likely contributed to these disappearances (EAI 2017).

FPL is in the process of implementing a Nutrient Management Plan as a requirement of the FDEP Consent Order. The plan includes an initiative to re-establish seagrass meadows in the CCS. FPL (2016k) states in its Nutrient Management Plan that a healthy seagrass population growing over approximately 50 percent of the CCS surface water acreage would help balance and sequester the CCS's nutrient content. FPL's plan to re-establish seagrass is described in more detail in Section 3.7.3, "Aquatic Resources on the Turkey Point Site," of this SEIS. To date, FPL has identified no clear evidence that the CCS is having an ecological impact on Biscayne Bay or other adjacent surface waters (see Section 3.7.4, "Biscayne Bay and Card Sound Semiannual Monitoring," for more details) (E&E 2017).

Possible Construction and Operation of New Industrial Facilities

Since the NRC published its EIS for the Turkey Point Units 6 and 7 combined licenses in 2016 (NRC 2016a), the NRC staff has identified several new industrial facilities that may be constructed and operated in the vicinity of the Turkey Point site. These include a mine, a Miami-Dade County wastewater treatment facility, and the expansion of the Turkey Point ISFSI. Construction (or expansion) of these facilities could result in the temporary or permanent loss of wetlands and mangrove forests that function as important habitats for early life stages of fish and shellfish. Any permanent losses of aquatic habitats could create habitat fragmentation that would affect ecosystem function and connectivity. Habitat degradation associated with runoff, erosion, and sedimentation during construction could also occur. Additionally, direct mortality of aquatic organisms could result from dredging, wetland and mangrove filling, and other necessary in-water work. Barge traffic associated with delivery of construction supplies and plant components to the site would release pollutants into aquatic habitats and could result in collision-related mortality of larger aquatic organisms, especially turtles and marine mammals. Appropriate permits would mitigate some water quality and aquatic resource impacts by requiring implementation of best management practices or other mitigation during construction and/or operation. The USACE or the FDEP would oversee applicable Clean Water Act permitting, including Section 404 permits for dredging and fill activities, Section 401 certification, and Section 402(p) NPDES general stormwater permitting. Once built, operation of these new facilities would likely have minimal to no discernable impacts on aquatic resources.

Climate Change

Section 4.15.3.2, "Climate Change," of this SEIS describes current climate change research and predictions across the contiguous United States as well as specific to the Southeast region of the United States and South Florida. The NRC staff also describes in that section the climate changes expected to occur over the course of the Turkey Point subsequent license renewal term, based on currently available climate model simulations. The primary climate changes that could affect aquatic resources during this timeframe include sea level rise of between 0.5 to 1.2 feet (0.15 to 0.37 m) by 2050 and increased storm frequency and intensity.

Sea level rise would likely alter the hydrological regime and flow and could result in saltwater intrusion, erosion, and inundation of coastal areas. This would affect the quality, quantity, and spatial distribution of wetlands and mangrove forests. Some of these habitats could become open water, which would reduce available nursery habitat for early life stages of many fish and shellfish. Loss of such habitats could affect the success of ongoing and planned restoration activities in the region. For example, in an analysis of the effects of climate-induced sea level rise on the success of the Biscayne Bay Coastal Wetlands Phase 1 Project, the USACE and the SFWMD estimated that by 2032, approximately 8 percent of the project's ecosystem benefits were likely to be at risk from sea level rise; and by 2062, the project's expected benefits would be diminished by 41 percent (USACE and SFWMD 2011).

Storm frequency and duration would also affect aquatic habitats and coastal wetlands and mangroves. If storm intensities and durations increase, these important habitats would be more likely to suffer damage, which could affect hydrological regimes, quality, quantity, and ecosystem function until those habitats recover. Also, with increased storm frequency, these habitats would not have as much time to recover between storms. This would affect the coasts' ability to serve as a nursery for fish and shellfish, and this could have cascading population effects over time for those species that are highly dependent upon wetlands and mangroves during early life stages.

Another potential climate change-induced stressor on the aquatic environment in the geographic area of interest is the likely use of additional shoreline infrastructure or armoring to protect cities, urban areas, roads, bridges, and agricultural lands from rising sea levels. For instance, in Miami-Dade County, 4,358 km^2 (2,708 mi^2) of land are at elevations of 5 m (16.4 feet) or less, and 3,500 km^2 (2,174 mi^2) of land are 2 m (6.6 feet) or lower (Cela et al. 2010). Shoreline protection efforts in these areas could contribute to habitat fragmentation or interfere with activities designed to restore historic hydrological flow and ecological connections. Dredging and other in-water work associated with shoreline protection infrastructure could result in erosion, sedimentation, and water-quality degradation, although implementation of best management practices and appropriate State and Federal water quality permits would mitigate such effects. Direct injury or mortality of aquatic organisms could also result from these activities. Associated barge traffic and construction equipment use would release pollutants into aquatic habitats and could result in collision-related injury or mortality of larger aquatic organisms, especially turtles and marine mammals. Coupled with continued population growth and urbanization, shoreline protection infrastructure that becomes a permanent part of the coastal landscape could dramatically influence the future of aquatic resources in South Florida.

4.16.5 Socioeconomics

This section addresses socioeconomic factors that have the potential to be directly or indirectly affected by changes in operations at Turkey Point in addition to the aggregate effects of other past, present, and reasonably foreseeable future actions. The region of influence (ROI) considered in this cumulative analysis is Miami-Dade County, where approximately 85 percent of FPL employees reside (see Table 3-14). This is where the economy, tax base, and infrastructure would most likely be affected because the majority of Turkey Point workers and their families reside, spend their incomes, and use their benefits within Miami-Dade County. As discussed in Section 4.10, "Socioeconomics," continued operation of Turkey Point during the subsequent license renewal period would result in SMALL socioeconomic impacts.

Past, present, and reasonably foreseeable future actions within the ROI could contribute to cumulative socioeconomic impacts. Relevant actions in this cumulative impact analysis include future planned activities at the Turkey Point site that are unrelated to the proposed action of subsequent license renewal, future urbanization, population increases, transportation infrastructure projects, and other reasonably foreseeable planned offsite activities. Future activities and planned projects in the ROI could bring additional workers and traffic, thus increasing the local population and causing increased traffic on local roads and increased demand for public services. For instance, the construction and operation of the proposed new Turkey Point Units 6 and 7 would have an impact on Miami-Dade County's economy including impacts from traffic in the immediate vicinity of the Turkey Point site (NRC 2016a). For instance, construction and operation of Turkey Point Units 6 and 7 would result in beneficial socioeconomic impacts including additional wages, tax revenue, and jobs. However, construction and operation of Turkey Point Units 6 and 7 would have adverse impacts on traffic as a result of additional worker and delivery vehicles. Transportation infrastructure projects throughout the region can have beneficial impacts on road quality and infrastructure. Miami-Dade County has experienced increased migration into the county as a result of the continuing effects of Hurricane Maria, which occurred in 2017 (BEBR 2018); increases in population (see Table 3-17) can increase the demand for public services.

Changes in climate conditions could impact certain industries such as tourism and recreation, which create jobs and bring significant revenue to regional economies. The U.S. Global Change Research Program reports that climate changes (increases in ambient temperatures and humidity) in the Southeast region of the United States by the year 2050 could create unfavorable summertime outdoor conditions for recreation and tourism (USGCRP 2014). The Everglades and Florida Keys are vulnerable to sea level rise and the effects of climate change impacts on the availability and quality of these resources can result in tourism and revenue loss (USGCRP 2014). Changes or fluctuations in sea levels, storm surges, erosion, and sedimentation could affect port operations and the economic activities that ports support. In 2016, Port Miami contributed approximately $1.3 billion in State and local taxes, supported approximately 324,400 jobs (including direct, indirect, and induced jobs) as a result of cargo and cruise activity, and saw approximately 5.3 million passengers pass through its portals (Port Miami 2017). Additionally, most of the petroleum products consumed by Florida are delivered by barge to ports (USGCRP 2009). Rising sea levels and extreme weather events can damage roads and coastal infrastructure. Property values are also vulnerable to sea level rise; studies indicate that properties in lower elevations sell for less or gain in value more slowly than those located in higher elevations (Keenan et al. 2018, Bernstein et al. 2017). Therefore, climate changes in the ROI could result in adverse socioeconomic and transportation impacts.

4.16.6 Historic and Cultural Resources

As described in Section 4.9, “Historic and Cultural Resources,” of this SEIS, historic structures and properties within the area of potential effect are not likely to be adversely affected by subsequent license renewal-related activities since the site area has low historical, cultural and archeological potential, and no ground-disturbing activities or physical changes would occur at Turkey Point during the subsequent license renewal term beyond ongoing maintenance activities. As discussed in Section 4.9, FPL has administrative controls on how to handle unanticipated historical and cultural finds related to potential ground-disturbing activities. Additionally, FPL provides training sessions to Turkey Point staff to ensure that plant personnel consider cultural resources during planned maintenance activities.

As described in Section 3.9, “Historic and Cultural Resources,” of this SEIS, the geographic area considered in this analysis is the area of potential effect associated with the proposed undertaking (subsequent license renewal for Turkey Point Units 3 and 4). In the NRC staff’s EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG-2176), Table 7-1 summarizes present and reasonably foreseeable future actions that could affect historic properties at the Turkey Point site. Direct impact would occur if historic and cultural resources in the area of potential effect were physically removed or disturbed. For instance, the potential expansion of the ISFSI, the construction of a wastewater treatment facility, and the expansion of roads (transportation projects) could have direct impacts on cultural resources through inadvertent discovery during ground-disturbing activities or result in new above-ground structures that affect the visual area of potential effect. However, reasonable onsite activities conducted on the Turkey Point site could avoid the areas where historic structures, such as the McGregor Smith Cottage, are located. As discussed in Section 4.9.1.3, “Findings,” based on cultural resource surveys, the Turkey Point site has a low archeological potential. Additionally, FPL has administrative controls in place on how to handle unanticipated historical and cultural finds related to potential ground-disturbing activities.

Changes or fluctuations in sea levels because of climate change could result in the disturbance or loss of terrestrial historic and cultural resources from flooding, increased erosion, or inundation of shorelines and surrounding areas. As discussed in Section 4.15.3.2, “Climate Change,” of this SEIS, sea level is projected to continue to rise. Because of water-level changes, historic and cultural resources could be lost before they could be documented or studied. Rising sea levels, loss of land, and changes in temperature can affect the availability and access to local plant and animal species, thereby impacting the tribal communities who have historically depended on them for food or medicine (USGCRP 2014).

4.16.7 Human Health

The NRC and EPA have established radiological dose limits to protect the public and workers from both acute and long-term exposure to radiation and radioactive materials. These dose limits are in 10 CFR Part 20, “Standards for Protection Against Radiation,” and 40 CFR Part 190, “Environmental Radiation Protection Standards for Nuclear Power Operations.” As discussed in Section 4.11, “Human Health,” of this SEIS, the impacts to human health from continued plant operations during the subsequent license renewal term are SMALL. For the purposes of this cumulative impacts analysis, the geographical area considered is the area within a 50-mi (80-km) radius of Turkey Point Units 3 and 4. There are no other nuclear power plants within this 50-mi (80-km) radius. However, that radius does overlap with the 50-mi (80-km) radius around proposed Turkey Point Units 6 and 7, which would be sited directly adjacent to Turkey Point Units 3 and 4. As discussed in Section 3.1.4.4, “Radioactive Waste

Storage," of this SEIS, FPL stores spent nuclear fuel from Units 3 and 4 in a storage pool and in an onsite independent spent fuel storage installation (ISFSI). As a reasonably foreseeable future project, FPL has stated that if the DOE does not take ownership of onsite commercial spent nuclear fuel by 2031, FPL may need to expand the Turkey Point Units 3 and 4 ISFSI storage capability to account for the additional spent nuclear fuel generated during the subsequent license renewal term.

Another reasonably foreseeable future action with the potential to contribute to cumulative radiological impacts is the proposed construction and operation of two new nuclear units (Turkey Point Units 6 and 7) at the Turkey Point site. The operation of Turkey Point Units 6 and 7 would result in radiological releases and dose impacts to workers and the public, in addition to the impacts resulting from operation of Units 3 and 4. Also, spent fuel would accumulate onsite as a result of the operation of Units 6 and 7, in addition to the spent fuel produced by operation of Units 3 and 4. Sections 5.93, "Impacts on Members of the Public," 5.94, "Occupational Doses to Workers," and 6.1.6, "Radiological Wastes," of the NRC staff's EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG–2176) (NRC 2016a) describe those impacts in detail. The NRC staff incorporates those impact analyses from NUREG–2176 into this SEIS by reference.

EPA regulations in 40 CFR Part 190 limit the dose to members of the public from all sources in the nuclear fuel cycle, including nuclear power plants, fuel fabrication facilities, waste disposal facilities, and transportation of fuel and waste. As discussed in Section 3.1.4.5 in this SEIS, FPL has a radiological environmental monitoring program (REMP) that measures radiation and radioactive materials in the environment from Turkey Point Units 3 and 4, its ISFSI, and all other sources. The NRC staff reviewed the radiological environmental monitoring results for the 5-year period from 2014 through 2018 as part of this cumulative impacts assessment. The review of FPL's data showed no indication of an adverse trend in radioactivity levels in the environment from either Turkey Point Units 3 and 4 or the ISFSI. The data showed that there was no measurable impact to the environment from operations at Turkey Point Units 3 and 4. Also, since the proposed Units 6 and 7 would operate under the same State and Federal regulatory standards as Units 3 and 4, there would be no significant impact on the environment from the operation of the proposed Turkey Point Units 6 and 7.

In summary, the NRC staff concludes that there is no significant cumulative effect on human health resulting from the proposed action of subsequent license renewal, in combination with cumulative impacts from other sources. The NRC staff bases this conclusion on its review of radiological environmental monitoring program data, radioactive effluent release data, worker dose data; the expectation that Turkey Point Units 3 and 4 would continue to comply with Federal radiation protection standards during the period of extended operation; and the continued regulation of any future development or actions in the vicinity of the Turkey Point site (including proposed Turkey Point Units 6 and 7) by the NRC and the State of Florida.

4.16.8 Environmental Justice

The environmental justice cumulative impact analysis evaluates the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from past, present, and reasonably foreseeable future actions, including the continued operational effects of Turkey Point Units 3 and 4 during the subsequent license renewal term. The geographic area of interest for this environmental justice cumulative impact analysis is the area within a 50-mi (80-km) radius of Turkey Point. As discussed in Section 4.12, "Environmental Justice," of this SEIS, there would be no disproportionately high and adverse impacts on minority and low-income populations from the continued operation of Turkey Point Units 3 and 4 during the subsequent license renewal term.

Contributory cumulative effects could come from the other reasonably foreseeable future planned activities at or near the Turkey Point site that are unrelated to the proposed action (subsequent license renewal), as well as from other reasonably foreseeable planned offsite activities. Potential impacts to minority and low-income populations from the construction and operation of proposed reactors Turkey Point Units 6 and 7 would mostly consist of certain localized environmental effects (such as noise, air emissions, traffic, and housing impacts). However, the NRC staff did not identify any disproportionately high and adverse impacts on minority and low-income populations that would occur as a result of the construction and operation of the proposed Turkey Point Units 6 and 7. Transportation projects can have disproportionately high and adverse impacts on minority and low-income populations if the projects bisect any minority or low-income neighborhoods, require the displacement of residences in those neighborhoods, or result in minority or low-income populations disproportionately bearing the effects of the project.

Changes in climate conditions could disproportionately affect minority and low-income populations. The U.S. Global Change Research Program (USGCRP 2009) states that "people living in poverty are especially at risk from a variety of climate-related health effects." The greatest health burdens are likely to fall on the poor, especially those lacking adequate shelter and access to resources such as air conditioning (USGCRP 2014a). Climate change could affect the availability and access to local plant and animal species, thereby impacting the tribal communities that have historically depended on them for food or medicine (USGCRP 2014). In coastal regions, social and cultural disparities vary regionally and social factors (i.e., low-income, minority status, educational achievement) can limit the ability of some people to adapt to changing environmental conditions caused by climate change. This can result in the displacement of vulnerable minority and low-income populations and lead to social disruption. As discussed in Section 4.15.3 of this SEIS, climate change can result in decreases in water availability and water quality as a result of saltwater intrusion into coastal fresh groundwater supplies. This has significant implications for Miami-Dade County's public water supply systems as well as for private and industrial users of groundwater aquifers. As discussed in Section 3.10.3, according to the 2010 Census (USCB 2010a), minorities (race and ethnicity combined) comprised approximately 85 percent of the total population in Miami-Dade County. Therefore, climate change effects on groundwater availability and quality would be disproportionately borne by the minority populations that Miami-Dade County water treatment plants serve.

4.16.9 Waste Management and Pollution Prevention

This section describes waste management impacts during the subsequent license renewal term when combined with the aggregate effects of other past, present, and reasonably foreseeable future actions. For the purpose of this cumulative impacts analysis, the NRC staff considered the area within a 50-mi (80-km) radius of Turkey Point. In Section 4.11, "Human Health," the NRC staff concluded that the potential human health impacts from Turkey Point's waste during the subsequent license renewal term would be SMALL.

As discussed in Sections 3.1.4 and 3.1.5 of this SEIS, FPL maintains waste management programs for radioactive and nonradioactive waste generated at Turkey Point Units 3 and 4 and is required to comply with Federal and State permits and other regulatory waste management requirements. The nuclear power plants and other facilities within a 50-mi (80-km) radius of Turkey Point Units 3 and 4 are also required to comply with appropriate NRC, EPA, and State requirements for the management of radioactive and nonradioactive waste. Current waste management activities at Turkey Point Units 3 and 4 would likely remain unchanged during the subsequent license renewal term, and the NRC staff expects that FPL will continue to comply with Federal and State requirements for radioactive and nonradioactive waste.

Due to the comprehensive regulatory controls in place for management of radioactive waste, FPL's compliance with these regulations, and its use of licensed treatment and disposal facilities, the impacts of radioactive waste are expected to be SMALL during the subsequent license renewal term. There are no other operating nuclear power plants, fuel-cycle facilities, or radiological waste treatment and disposal facilities within a 50-mi (80-km) radius of Turkey Point. There are industrial, medical, and research facilities in the region that use radioactive materials. The NRC staff's EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG–2176, Volume 1, Section 7.8) (NRC 2016a) analyzed the cumulative impacts of managing radioactive waste within a 50-mi (80-km) radius of Turkey Point and determined the cumulative impact to be SMALL. The NRC staff likewise expects that the cumulative impact of radioactive waste management, including the impacts from Turkey Point subsequent license renewal, will be SMALL, given the regulatory controls in place for radioactive waste treatment and disposal, FPL's established waste management practices, and its use of licensed treatment and disposal facilities.

Continued operation of Turkey Point would have a small impact on nonradioactive waste management facilities given FPL's program for waste management and the availability of treatment and disposal facilities. The NRC staff's EIS for the Turkey Point Units 6 and 7 combined licenses (NUREG–2176, Volume 1, Section 7.9) analyzed the cumulative impacts of nonradioactive waste from past, present, and future projects in the geographic area of interest of Miami-Dade County. The EIS concluded that the cumulative impacts from nonradioactive waste management would be SMALL. The NRC staff expects that FPL would continue its programs of waste management and will continue to comply with its permits and waste management regulations. Given that facilities within Miami-Dade County are also required to comply with appropriate EPA and state requirements for the management of hazardous and nonhazardous waste, and that state and local authorities would ensure that FPL continues to comply with regulations governing waste management, the cumulative impact of nonradioactive waste management would be small.

The additional 20 years of spent nuclear fuel generated during the subsequent license renewal term would be stored in the spent fuel pools until adequately cooled and then transferred to dry storage in an ISFSI. The Turkey Point onsite ISFSI is licensed under the general license provided to power reactor licensees under 10 CFR 72.210. The NRC oversight of onsite spent fuel storage ensures that the increased volume in onsite storage can be safely accommodated with little environmental effect. No new and significant information has been identified for this issue; therefore, no further analysis is required. The issue was also considered for Turkey Point's initial license renewal environmental review, and no new and significant information was found at that time (NRC 2002c).

In summary, the NRC staff concludes that there would be no significant cumulative effect from the generation of radioactive and nonradioactive waste during the period of extended operation authorized by the proposed action of subsequent license renewal. The NRC staff bases its conclusion on the continued compliance of FPL with Federal and State of Florida requirements for radioactive and nonradioactive waste management and on the expected regulatory compliance of other waste producers in the area.

4.16.10 Global Greenhouse Gas Emissions

The cumulative impact of a greenhouse gas emission source on climate is global. Greenhouse gas emissions are transported by wind and become well mixed in the atmosphere as a result of their long atmospheric residence time. Therefore, the extent and nature of climate change is not specific to where greenhouse gases are emitted. Due to the global significance of greenhouse gas emissions, a global climate change cumulative impacts analysis inherently considers the entire Earth's atmosphere and, therefore, emissions on a global scale (as opposed to simply those emissions on a county, State, or national scale). As discussed in Section 4.15.3.2, "Climate Change," of this SEIS, climate change and climate-related environmental changes have been observed on a global level, and climate models indicate that future climate change will depend on present and future global greenhouse gas emissions. Climate models indicate that short-term climate change (through the year 2030) is dependent on past greenhouse gas emissions. Therefore, short-term climate change is projected to occur with or without present and future greenhouse gas emissions from Turkey Point. Beyond the short term, climate models indicate that with continued increases in global greenhouse gas emission rates the Earth's average surface temperature will continue to increase and climate-related changes will persist.

In April 2018, EPA published its latest Greenhouse Gas Inventory report, "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2016." As the official U.S. inventory of greenhouse gas emissions, this EPA report identifies and quantifies the primary anthropogenic sources (those human caused or produced) and sinks of greenhouse gases. The Greenhouse Gas Inventory is an essential tool for addressing climate change and for participating with the United Nations Framework Convention on Climate Change to compare the relative global contribution of different emission sources and greenhouse gases to climate change. In 2016, the United States emitted 6,511.3 million metric tons (MMT) of $CO_{2eq.}$ From 1990 to 2016, emissions increased by 2.4 percent. However, from 2015 to 2016, emissions decreased by 1.9 percent. Across the United States, emissions attributable to electricity generation totaled 1,809.3 MMT of CO_{2eq} (EPA 2018c). The Energy Information Administration (EIA) reported that in 2015, Florida's electric power sector was responsible for 107.6 MMT of CO_{2eq} (EIA 2018e).

Facilities that emit 25,000 MT CO_{2eq} or more per year are required to annually report their greenhouse gas emissions to the EPA. These facilities are known as direct emitters, and the data are publicly available in EPA's facility-level information on greenhouse gases tool (FLIGHT). In 2016, FLIGHT-identified facilities in Florida emitted a total of 134 MMT of $CO_{2eq.}$ Facilities in Miami-Dade County emitted a total of 4.95 MMT of CO_{2eq} (EPA 2018d).

Section 4.16, "Cumulative Impacts," of this SEIS references current and reasonably foreseeable future projects and actions that could contribute to greenhouse gas emissions. Permitting and licensing requirements and other mitigative measures can minimize the impacts of greenhouse gas emissions. For instance, in 2012, EPA issued a final Greenhouse Gas Tailoring Rule (77 FR 41051) to address greenhouse gas emissions from stationary sources under the Clean Air Act permitting requirements. The Greenhouse Gas Tailoring Rule establishes when an emission source will be subject to permitting requirements and control technology to reduce greenhouse gas emissions.

EPA's Greenhouse Gas Inventory illustrates the diversity of greenhouse gas sources, which include electricity generation (including fossil fuel combustion and incineration of waste), industrial processes, and agriculture. As presented in Section 4.15.3.1, "Greenhouse Gas Emissions and Climate Change," of this SEIS, annual direct greenhouse gas emissions from combustion sources resulting from ancillary operations at Turkey Point range from 3,900 to 4,190 MT of CO_{2eq}. In comparing Turkey Point's greenhouse gas emission to total U.S. greenhouse gas emissions, emissions from electricity production in Florida, or emissions on a county level, greenhouse gas emissions from Turkey Point are relatively minor. When compared to global emissions, greenhouse gas emissions associated with Turkey Point Units 3 and 4 operations are negligible (see Table 4-8 below). Furthermore, as presented in Table 4-7, "Direct Greenhouse Gas Emissions from Facility Operations Under the Proposed Action and Alternatives," in Section 4.15.3.1, the natural gas and combination alternatives' annual greenhouse gas emissions are higher by several orders of magnitude than those from the continued operation of Turkey Point Units 3 and 4. If Turkey Point's generating capacity were to be replaced by other non-nuclear power generating alternatives evaluated in this SEIS, there would be an increase in greenhouse gas emissions. Consequently, the NRC staff concludes that the continued operation of Turkey Point through the subsequent license renewal period (the proposed action) would result in greenhouse gas emissions avoidance. In other words, when compared to alternative baseload replacement power generation sources considered in this SEIS, the continued operations of Turkey Point Units 3 and 4 would have a net, beneficial contribution to greenhouse gas emissions and climate change impacts during the subsequent license renewal term.

Table 4-8 Comparison of Greenhouse Gas Emission Inventories

Source	CO_{2eq} MMT/year
Global Emissions (2016) [(a)]	37,000
U.S. Emissions (2016)[(b)]	6,511
Florida (2016)[(c)]	134
Miami-Dade County, Florida (2016)[(c)]	4.95
Turkey Point [(d)]	4.2×10^{-3}

[(a)] Carbon dioxide emissions obtained from the Global Carbon Project (GCP 2018) and converted to carbon dioxide equivalents (CO_{2eq}).
[(b)] Source: EPA 2018c.
[(c)] Greenhouse gas emissions account only for direct emitters, those facilities that emit 25,000 MT or more a year (EPA 2018d).
[(d)] Peak emissions over the last 5 years from FPL 2018f.

Source: GCP 2018, EPA 2018c, EPA 2018d, FPL 2018f

4.17 Resource Commitments Associated with the Proposed Action

This section describes the NRC staff's consideration of potentially unavoidable adverse environmental impacts that could result from the implementation of the proposed action (subsequent license renewal) and alternatives to the proposed action, the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity, and the irreversible and irretrievable commitments of resources.

4.17.1 Unavoidable Adverse Environmental Impacts

Unavoidable adverse environmental impacts are impacts that would occur after implementation of all workable mitigation measures. Carrying out any of the replacement energy alternatives considered in this SEIS, including the proposed action of subsequent license renewal for Turkey Point Units 3 and 4, would result in some unavoidable adverse environmental impacts.

Minor unavoidable adverse impacts on air quality would occur due to emission and release of various chemical and radiological constituents from power plant operations. Non-radiological emissions resulting from power plant operations are expected to comply with EPA emissions standards, although the alternative of operating a fossil-fueled power plant in some areas may worsen existing attainment issues. Chemical and radiological emissions would not exceed the national emission standards for hazardous air pollutants.

During nuclear power plant operations, workers and members of the public would face unavoidable exposure to minor levels of radiation as well as to hazardous and toxic chemicals. Workers would be exposed to radiation and chemicals associated with routine plant operations and the handling of nuclear fuel and waste material. Workers would have higher levels of exposure than members of the public, but doses would be administratively controlled and would not exceed regulatory standards or administrative control limits. In comparison, the alternatives involving the construction and operation of a non-nuclear power generating facility would also result in unavoidable exposure to hazardous and toxic chemicals to workers and the public.

The generation of spent nuclear fuel and waste material—including low-level radioactive waste, hazardous waste, and nonhazardous waste—would be unavoidable. Non-nuclear power generating facilities would generate both hazardous and nonhazardous waste. For wastes generated during operations, power plant operators would collect, store, and ship these for suitable treatment, recycling, or disposal in accordance with applicable Federal and State regulations. Due to the costs of handling these materials, the NRC staff expects that power plant operators would optimize all waste management activities and operations in a way that generates the smallest possible amount of waste.

4.17.2 Relationship between Short-Term Use of the Environment and Long-Term Productivity

The operation of power generating facilities would result in short-term uses of the environment, as described in Chapter 4, "Environmental Consequences and Mitigating Actions," of this SEIS. Short term is the period of time that continued power generating activities take place.

Power plant operations require short-term use of the environment and commitment of resources (e.g., land and energy), indefinitely or permanently. Certain short-term resource commitments are substantially greater under most energy alternatives, including subsequent license renewal, than under the no-action alternative because of the continued generation of electrical power and the continued use of generating sites and associated infrastructure. During operations, all energy alternatives entail similar relationships between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.

Air emissions from nuclear power plant operations introduce small amounts of radiological and non-radiological emissions to the region around the plant site. Over time, these emissions would result in increased concentrations and exposure, but the NRC staff does not expect that these emissions would impact air quality or radiation exposure to the extent that they would impair public health and long-term productivity of the environment.

Continued employment, expenditures, and tax revenues generated during power plant operations directly benefit local, regional, and State economies over the short term. Local governments investing project-generated tax revenues into infrastructure and other required services could enhance economic productivity over the long term.

The management and disposal of spent nuclear fuel, low-level radioactive waste, hazardous waste, and nonhazardous waste requires an increase in energy and consumes space at treatment, storage, or disposal facilities. Regardless of the location, the use of land to meet waste disposal needs would reduce the long-term productivity of the land.

Power plant facilities are committed to electricity production over the short term. After decommissioning these facilities and restoring the area, the land could be available for other future productive uses.

4.17.3 Irreversible and Irretrievable Commitment of Resources

Resource commitments are irreversible when primary or secondary impacts limit the future options for a resource. For example, the consumption or loss of nonrenewable resources are irreversible. An irretrievable commitment refers to the use or consumption of resources for a period of time (e.g., for the duration of the action under consideration) that are neither renewable nor recoverable for future use. Irreversible and irretrievable commitments of resources for electrical power generation include the commitment of land, water, energy, raw materials, and other natural and man-made resources required for power plant operations. In general, the commitments of capital, energy, labor, and material resources are also irreversible.

The implementation of any of the replacement energy alternatives considered in this SEIS would entail the irreversible and irretrievable commitments of energy, water, chemicals, and—in some cases—fossil fuels. These resources would be committed during the subsequent license renewal term and over the entire life cycle of the power plant, and they would be unrecoverable.

Energy expended would be in the form of fuel for equipment, vehicles, and power plant operations and electricity for equipment and facility operations. Electricity and fuel would be purchased from offsite commercial sources. Water would be obtained from existing water supply systems. These resources are readily available, and the NRC staff does not expect that the required amounts would deplete available supplies or exceed available system capacities.

Response: *The statement in the SEIS was not intended to state that historic and archaeological resources were present within the Turkey Point footprint prior to the construction of Turkey Point Units 3 and 4, as it is unknown if historic and archaeological resources were present prior to construction because cultural resources surveys had not been conducted. The NRC staff revised the subject statement in Section 3.9.2 to clearly state that it is unknown whether historic or cultural resources were disturbed previously.*

A.2.11 Groundwater Hydrology and Quality

Comment: Section 3.5, Page 3-31,3-32. The DSEIS states: "At the Turkey Point site, surface water (including the area's freshwater canals, wetlands, and the adjoining Biscayne Bay) and groundwater are closely connected. This close relationship is attributable to the very high permeability of the underlying Biscayne aquifer, which permits water to move relatively freely between the surface and subsurface and vice versa. As a result, the CCS is hydraulically connected to surface waters including Biscayne Bay via the groundwater pathway." This statement does not distinguish hydraulic characteristics and dynamics of fluid flow. Consequently, there is insufficient information to establish that CCS water is moving into Biscayne Bay or adjacent surface water bodies, that waters from the adjacent water bodies are flowing into the CCS, or whether surface waters from the CCS and surrounding water bodies are not interacting at all.The last sentence should be revised to: "Surface waters in the CCS are hydraulically connected to groundwater within the Biscayne aquifer. Surface waters outside the Plant are also hydraulically connected to the Biscayne aquifer. Flow between surface waters and groundwaters are governed by a variety of factors include stage/hydraulic head gradients, hydraulic conductivity of sedimentation, hydraulic conductivities of aquifer materials, porosity, and fluid density gradients. Transport of surface water sediments and/or dissolved chemical constituents are further complicated by factors such as impingement, diffusion, dispersion, chemical reactions with matrix materials, biologic attenuation, decay/chemical breakdown, temperature/ fluid density gradients etc. All of these factors need to be considered in order to establish, and the degree to which, surface and groundwaters interact." (**0017-1-18** [Maher, William])

Comment: Failure to Accurately Characterize Connectivity Between CCS and Surrounding Environment

In the DSEIS, NRC staff fail to present a consistent, accurate characterization of the connectivity between the CCS and surrounding ground and surface water and thus fail to adequately analyze the significance and impacts of these interactions. DSEIS language regarding how the CCS connects to the surrounding environment is contradictory and NRC staff somehow refer to the CCS as a closed system while simultaneously recognizing the contribution of water from the CCS into the surrounding environment because of hydrologic connectivity. NRC staff write that, "at Turkey Point, water from the cooling water loop is discharged into a closed body of water called the cooling canal system."11 Indeed, NRC staff incorrectly state that "the CCS does not connect to any other surface water bodies,"12 and that, in order to comply with a 1971 consent decree that required FPL to discharge cooling water from plant operations into a closed-cycle cooling canal system, "FPL designed and constructed the CCS and ensured that it had no surface water connection to any outside water body."13

And yet, NRC staff go on to explicitly recognize the connectivity between the CCS and outside water bodies: "Water in the CCS is in direct contact with the Biscayne Aquifer and with earthen plugs located in the perimeter of the CCS."14 This connectivity results in water leaving the CCS

via the Biscayne Aquifer, with more water moving from the CCS into the aquifer than water moving from the aquifer into the CCS.15 Indeed, *the CCS affects the hydrology and groundwater quality of the Biscayne aquifer. The CCS is unlined and hydraulically connected to the upper Biscayne aquifer because permeable aquifer strata permit the movement of water between the aquifer and the CCS."16
11 United States Nuclear Regulatory Commission, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 5, Second Renewal Regarding Subsequent License Renewal for Turkey Point Nuclear Generating Unit Nos. 3 and 4, Draft Report for Comment, NUREG-1437 Supplement 5 Second Renewal, March 2019, pg. 3-4, emphasis added.
12 Ibid., 3-5
13 Ibid., 3-8, 3-9
14 Ibid., 3-11
15 Ibid., 3-11
16 Ibid., 3-55 (**0023-6** [McLaughlin, Caroline])

Response: *The SEIS, including Sections 3.1.1, 3.1.3, and 3.5, was revised to clarify the description of hydrologic connections between surface water bodies and groundwater. In particular, references to the cooling canal system as a closed body of water were revised for clarity, and text was further revised to clearly specify that the connection between the CCS and surrounding surface water bodies is via the Biscayne aquifer groundwater pathway, with no direct connection between the CCS and other surface water bodies. A detailed description of the staff's evaluation of water resources at the site and the surrounding area is contained in Section 3.5 of the SEIS.*

Comment: Section 3.5, Page 3-64. The DSEIS states, "Well locations TPGW-10S/D, TPGW-11S/D, TPGW-13S/D, and TPGW-14S/D are offshore in Biscayne Bay." This statement is inaccurate because TPGW-13 is not located off-shore, but located at the center of the CCS as stated in the previous sentence. This statement should be revised to remove "TPGW-13S/D". (**0017-2-1** [Maher, William])

Response: *The sentence in Section 3.5.2.2 of the SEIS was revised to delete the erroneous reference to TPGW-13S/D, and to be consistent with the figures in the SEIS.*

Comment: Section 3.5, Page 3-68. The DSEIS states, "While all wells had detectable ammonia, the concentrations were variable, ranging from a low of 0.17 mg/L at MW-3 adjacent to the intake canal and Biscayne Bay to a high of 4.6 mg/L at the South MW, as compared to the surface water quality standard of 0.5 mg/L." This statement is inaccurate because this is a GW sample and its concentration should be compared to the MDC GW standard. Additionally, there is no State groundwater criterion for ammonia. The statement should be revised to: *While all wells had detectable ammonia, the concentrations were variable, ranging from a low of 0.17 mg/L at MW-3 adjacent to the intake canal and Biscayne Bay to a high of 4.6 mg/L at the South MW, as compared to the Miami-Dade County groundwater standard of 0.5 mg/L." (**0017-2-2** [Maher, William])

Response: *The sentence in Section 3.5.2.2 of the SEIS was revised to clarify that the comparison is to the water quality standard for Miami-Dade County.*

Comment: Section 3.5, Page 3-82. The DSEIS states: "Each well is equipped with a 2,500-gpm (9,460 L/min) capacity pump (FDEP 2016b)." This statement is inaccurate because the wells do not have pumps as they produce water by natural artesian flow. This statement should be removed. (**0017-2-7** [Maher, William])

Response: *The sentence in Section 3.5.2.3 of the SEIS was revised to state the authorized maximum flow of 2,500 gpm for each well.*

Comment: Section 3.5, Page 3-85. The DSEIS Figure 3-16 defines the Unit 5 production wells as "Saline Wells" and the CCS freshening wells as "Floridan-Wells." The legend is confusing as both the Floridan freshening wells and the Unit 5 "PW" wells are producing brackish water from the Upper Floridan Aquifer (UFA). The legend should be revised to identify "F" wells (green triangles) as "UFA freshening Wells and "PW" wells (yellow circles) as "Unit 5 UFA Wells". (**0017-2-8** [Maher, William])

Response: *In preparing the SEIS, the NRC staff endeavored to be consistent with the well system descriptions and illustrations and to make maximum use of the illustrations provided in relevant documents, including FPL's Environmental Report and Turkey Point Remediation/Restoration Reports. The legend in the referenced figure was revised to differentiate between the site production and freshening wells, and Section 3.5.2 of the SEIS was revised to improve the clarity and consistency of the well designations.*

Comment: Section 3.5, Page 3-72. DSEIS Figure 3-14 depicts the location of RWS-3. This location depiction is incorrect. RWS-3 is located in the NW corner of the CCS. This Figure should be revised to depict the correct location for RWS-3 as identified in the Recovery Well System Startup Report provided in Enclosure 1 to FPL letter L-2019-031 dated April 3, 2019 (ADAMS Accession Nos. ML19095B380 and ML19095B382). (**0017-2-5** [Maher, William])

Response: *The referenced figure in Section 3.5.2.2 of the SEIS was revised to replace the graphic (Figure 2.2-1) from FPL's 2017 Annual Remediation/Restoration Report with the graphic (Figure 2.1-1) from FPL's Recovery Well System Startup Report, depicting the correct location of recovery well RWS-3.*

Comment: Section 3.5, Page 3-73. The DSEIS states: "FPL's modeling analysis indicates that operating the CCS with salinity in excess of 35 PSU is the single largest contributor to changes (movement) in the location of the saltwater interface, as measured by the areal extent of the saltwater interface." This statement is incomplete because, although the CCS was the single largest contributing factor, the other factors combined contributed more to the changes in the location of the saltwater interface, than the CCS alone. This statement should be revised to: "Although the CCS was the single largest contributing factor, the other factors combined contributed more to the changes in the location of the saltwater interface, than the CCS alone." (**0017-2-6** [Maher, William])

Response: *The statement in Section 3.5.2.2, subsection "Regulatory Developments with Respect to Cooling Canal System Operations and Groundwater Quality," of the SEIS describing the results of FPL's modeling to evaluate the relative contributions of factors affecting the movement of the saltwater interface in the Biscayne aquifer is correct as stated. However, the discussion has been expanded to provide additional context for clarity purposes.*

Comment: Section 3.5.2.2, Page 3-59. The DSEIS states: "FDEP has classified groundwater west of the Turkey Point site (i.e., to the west of the site boundary and CCS) as Class G-II, which means potable water use, with TDS levels of less than 10,000 mg/L (FPL 2018f)." This statement is inaccurate because it incorrectly suggests that the Biscayne aquifer is supposed to be G-II potable throughout its entire thickness west of the Plant Site. Prior to construction of the CCS, saltwater had already intruded into the Biscayne Aquifer for several miles inland. Near the coast, the aquifer was saline for the full depth of the aquifer (FPL 2018f). Moreover, the FDEP does not specifically list or map GW classifications in aquifers in Florida, rather the classifications are determined by rule criteria (See chapter 62-520.410, F.A.C.). This statement should be revised to: "Groundwater in the fresher upper portion of the Biscayne aquifer west of the Turkey Point site (i.e., to the west of the site boundary and CCS) is classified as Class G-II, which means potable water use, with TDS levels of less than 10,000 mg/L and G-III for those lower portions of the aquifer with TDS levels of 10,000 mg/L or greater which has been intruded with saline groundwater from Biscayne Bay since the 1950s (FPL 2018f)." (**0017-3-5** [Maher, William])

Response: *The statement cited by the commenter in Section 3.5.2.2 was revised and expanded to clarify that surficial groundwater west of the Turkey Point site has been classified by FDEP as G-II, consistent with FPL's Environmental Report and as defined by the Florida Department of Environmental Protection.*

Comment: Section 3.5.2.2, Page 3-62. The DSEIS states: "For groundwater monitoring, FPL's contractor performs quarterly field sampling from 14 well clusters, comprising 42 wells in total." This statement is inaccurate because it isn't consistent with Figure 3-12. This statement should be revised to: "... from 14 clusters and 5 historic wells used for salinity and temperature profiling, comprising 47 wells in total."
(**0017-3-6** [Maher, William])

Response: *Section 3.5.2.2 of the SEIS was revised to acknowledge that the five historical wells shown in the referenced figure, which has been renumbered in this SEIS, have been monitored since the 1970s to assess the impact of interceptor ditch operation on Biscayne Aquifer water quality, as described in FPL's August 2018 Turkey Point Plant Annual Monitoring Report.*

Comment: Section 3.5.2.2, Page 3-63. In Table 3-4, Table footnote: "M" incompletely characterizes the condition as *missing data' thus allowing for an improper noncompliance inference. The footnote should be modified to reflect the following basis for the 'missing data' condition: "missing data (parameter not required to be monitored)." (**0017-3-7** [Maher, William])

Response: *The table footnote cited by the commenter in Section 3.5.2.2 of the SEIS was revised for clarity as suggested.*

Comment: Section 3.5.2.2, Page 3-64. The DSEIS states: "Wells TPGW-1 through TPGW-7 are situated at various distances to the north and west of the CCS. Well cluster TPGW-7S/D can also be considered a sentinel well as it is the monitoring location nearest to the Miami-Dade County's Newton Wellfield that supplies potable water to municipal customers." The statement is misleading as it implies TPGW-7S/D is the last monitoring well between the SWI and the wellfield. There are multiple monitoring wells between the TPGW-7 site and the Newton Wellfield including wells monitored by FPL (including TPGW-20; one of 19 additional wells added to the original EPU monitoring well network shown on Figure 3-12), the USGS and MDC. The sentence implies saline GW could advance into the wellfield without advanced notification since TPGW-7D has become saline. In addition, FPL has monitoring well clusters west of TPGW-7 (TPGW-8 and 9 as shown on Figure 3-12). This statement should be modified to replace "TPGW-7" with "TPGW-9" and either remove the second sentence or replace with: "Additional monitoring wells that track the orientation of the saltwater interface (not shown on Figure 3-12) occur between the Newton Wellfield and the current location of the saltwater interface line." (**0017-3-8** [Maher, William])

Response: *The sentence cited by the commenter was revised for clarity and consistency with the 2009 Monitoring Plan (SFWMD 2009), and a description of additional groundwater monitoring required by the Miami-Dade County Consent Agreement and by the FDEP Consent Order was added to Section 3.5.2.2 of the SEIS.*

Comment: Section 3.5.2.2, Page 3-64. The DSEIS states: "Additionally, data from March 2011 are included to provide an historical baseline, representing the pre-extended power uprate monitoring period for Turkey Point." This statement creates the impression that in 2011, the saltwater interface was stable and could be used as a baseline condition upon which to assess the effects of the uprate on SWI movement. This is not supported by USGS studies that show the freshwater/saltwater interface is and has been moving inland throughout coastal Palm Beach, Broward and Miami Dade counties for decades due to numerous factors independent of Turkey Point. This statement should be revised to: "Additionally, data from March 2011 and 2017 are included to provide comparative water chemistry at selected monitor sites over a six year period." (**0017-3-9** [Maher, William])

Response: *The discussion cited by the commenter in Section 3.5.2.2 of the SEIS that discusses comparative groundwater monitoring results from the FPL uprate monitoring program along with the supporting data table were revised to clarify that the groundwater quality data presented is used to compare recent data with data from the pre-uprate monitoring period. In addition, the section was updated to include the most recent, published data from FPL's August 2018 Turkey Point Annual Monitoring Report (FPL 2018o) and other sources.*

Comment: Section 3.5.2.2, Page 3-64. The DSEIS states: "The current monitoring data (Table 3-5) also establish that TDS concentrations in Class G-II designated groundwater immediately to the west of the CCS boundary exceed the G-II standard (TDS of less than 10,000 mg/L)." The sentence makes statements regarding classifications of groundwater under current conditions in relation to presumed groundwater classification earlier in the history of the CCS without consideration of groundwater quality in the area west of the CCS prior to the Construction and operation of the CCS. Determinations whether state water quality criterion are exceeded are made by FDEP with full consideration of State groundwater quality rules. The presumption that G-II groundwater occurred immediately west of the CCS is not supported by historic data collected during the construction of the CCS in 1972 and 1973. For example, TPGW-1,2 and 4 are west of the CCS boundary in portions of the aquifer that exceeded 10,000 mg/L TDS threshold in 1972 before the CCS was operational. This statement should be revised to: "Prior to the construction of the CCS, non-potable groundwater with TDS levels exceeding 10,000 mg/L occurred in the lower portions of the Biscayne aquifer several miles west of the L-31E canal and the Plant Site. Shallow portions of the aquifer contained fresher groundwater the thickness of which increased with distance from the coast. Over the years since the CCS was constructed and operated, the salinities along the base of the aquifer increased and the thickness of the upper freshwater portion of the aquifer thinned. As discussed, there are multiple causes for these changes including the westward migration of hypersaline groundwater from beneath the CCS." (**0017-3-10** [Maher, William])

Response: *The paragraph in Section 3.5.2.2 of the SEIS was revised to clarify the staff's evaluation of the monitoring data, references to the FDEP groundwater classifications, and conclusions about the influence of the CCS on groundwater quality.*

Comment: Section 3.5.2.2, Page 3-69. The DSEIS states: "On April 25, 2016, the FDEP issued a warning letter (FDEP 2016c) expressing concern that CCS water was reaching Biscayne Bay." This paragraph is incomplete with regard to the resolution of the FDEP issue raised in the Warning Letter, consequently inadvertently creating a potential impression that operations of the CCS resulted in exceedances of surface water quality standards in Biscayne Bay. This statement should be revised to: "...expressing concern that CCS water was reaching Biscayne Bay and requested FPL provide facts that would assist the Department in determining whether any violations had occurred. On May 16, 2016, FPL submitted nutrient monitoring data to the Department from certain surface water monitoring stations in deep channels adjacent to the CCS for total nitrogen, total phosphorous, TKN, and chlorophyll a. The Department reviewed the information and determined that no exceedances of surface water quality standards were detected in Biscayne Bay monitoring. The Department concluded the Consent Order is intended to minimize the potential for future exceedances of surface water standards (FDEP, 2016a)." [See paragraph 17 of the FDEP CO]. (**0017-3-11** [Maher, William])

Response: *The statement in Section 3.5.2.2 of the SEIS is part of the description of the regulatory developments for the site and is correct as written with no implication for effects of CCS operations on Biscayne Bay water quality, which are discussed elsewhere in the SEIS. However, the text has been revised for clarity with a cross-reference added to Section 3.5.1.4 of the SEIS where nutrient monitoring is discussed in detail.*

Comment: Section 3.5.2.2, Page 3-70. The DSEIS states: "Between September 2016 and May 2018, the testing and recovery well systems have extracted and disposed of approximately 8,285 million gallons (31.4 million m3) of hypersaline groundwater, with the removal of 1.92 million tons (1.74 million metric tons) of salt from the Biscayne aquifer (FPL 2018h, 2018i)." The values stated are preliminary values that were finalized and changed during the data validation process (the validated values were reported to the regulatory agencies). This statement should be revised to include the following validated removal quantities: 7.63 billion gallons of hypersaline groundwater removed with an associated salt removal mass of 1.87 million tons. (**0017-3-12** [Maher, William])

Response: *Section 3.5.2.2 of the SEIS was revised to reflect the recovery well system performance reported in FPL's 2017 and 2018 Annual Remediation/Restoration Reports (FPL 2017b, FPL 2018p).*

Comment: Section 3.5.2.2, Page 3-70. The DSEIS states, "FPL has constructed five wells to date (i.e., wells F-1, F-2, F-3, F-4, and F-5)." This statement contains incorrect well identifiers. This statement should be revised to: "FPL has constructed wells F-1, F-3, F-4, F-5 and F-6. (**0017-3-13** [Maher, William])

Response: *Sections 3.5.2.2 and 4.5.1.2 of the SEIS were revised to remove the erroneous references to well F-2.*

Comment: Section 4.5.1.1, Page 4-23. The DSEIS states: "The program implemented by FPL to extract hypersaline groundwater from the Biscayne aquifer (on the west side of the CCS) is not designed to remove the hypersaline groundwater beneath Biscayne Bay (on the east side of the CCS)." The statement creates the impression that removal of hypersaline groundwater from the G-III groundwater under Biscayne Bay is an un-met requirement of FPL. The CCS is authorized to discharge to G-III groundwater by NPDES Permit (FL0001562). Groundwater beneath Biscayne Bay is and has been G-III non potable. CCS discharges to G-III groundwater beneath Biscayne Bay comply with state groundwater discharge rules and accordingly, FPL has not been required to extract hypersaline groundwater from beneath the Bay. This statement should be revised to: "...to extract hypersaline groundwater from the Biscayne aquifer (on the west side of the CCS) is not required or designed to remove the hypersaline groundwater beneath Biscayne Bay (on the east side of the CCS)." (**0017-4-6** [Maher, William])

Response: *Section 4.5.1.1 of the SEIS was revised; the sentence indicating that the recovery well system was not designed to extract hypersaline water to the east of the CCS was not essential to the paragraph and was deleted.*

Comment: Section 4.5.1.2, Page 4-25. The DSEIS states: "The hypersaline plume emanating from the CCS has migrated along the base of the Biscayne aquifer to the west into groundwater designated by the State as Class G-II, potable water use (defined as having total dissolved solids (TDS) levels of less than 10,000 mg/L)." This statement is not supported by data and conflicts with the finding in the FDEP CO. Paragraph 14 of the FDEP CO states: "On April 25, 2016, the Department issued a Notice of Violation (OGC File No.: 16-0241) ("NOV") to FPL stating that the CCS is the major contributing cause to the continuing westward movement of the saline water interface, and that the discharge of hypersaline water contributes to saltwater intrusion. In the NOV, the Department found that saltwater intrusion into the area west of the CCS is impairing the reasonable and beneficial use of adjacent G-II groundwater in that area." There was no finding, nor is FPL aware, of instances where hypersaline water emanating from the CCS has migrated into G-II groundwater as stated in the DSEIS. In fact, controlled-source electromagnetic (CSEM) surveying of the hypersaline groundwater identifies the western edge of the hypersaline as being 1 mile or more east of the area where G-II groundwater is being impacted by saltwater intrusion.

The statement should be revised to reflect FDEP findings that the CCS is a major contributing cause of SWI in the area but hypersaline groundwater from the CCS has not been found to be migrating into G-II groundwater. This is also supported by the SWI modeling that identified the CCS hypersaline water as the single largest contributing factor but the combined impact of the remaining seven SWI factors exceeded the influence of the CCS. See also the DSEIS sentence 36 - 39 on page 4-26. (**0017-4-8** [Maher, William])

Response: *Sections 3.5.2.2 and 4.5.1.2 of the SEIS were revised to delete inaccurate references indicating or implying that hypersaline water from the CCS has moved westward into groundwaters designated as Class G-II by the State of Florida.*

Comment: Section 4.5.1.2, Page 4-27. The DSEIS states, "Consistent with FPL's statements in its Environmental Report (FPL 2018f), the modeling results for the constructed well system predict retraction of the westward plume to the edge of the CCS by about 5 years and complete retraction within 10 years, with minor aquifer drawdown impacts." This statement is not accurate as retraction to the edge of the CCS will not be complete in 5 years. This statement should be revised to: "Groundwater models of the RWS indicate the westward migration of the hypersaline plume will be stopped in three years of operation, with retraction of the hypersaline plume north and west of the CCS beginning in 5 years. Retraction of the plume back to the FPL site boundary is projected in 10 years." (**0017-4-9** [Maher, William])

Response: *Section 4.5.1.2 of the SEIS was revised to clarify the statements regarding the results of groundwater modeling of the recovery well system operation reviewed by the NRC staff as well as statements attributed to FPL as contained in the Environmental Report (FPL 2018f).*

Comment: Section 4.5, Page 4-35. The DSEIS states, "Sanitary wastewater discharges to the Boulder Zone via Turkey Point's injection well and septic systems ...." Turkey Point does not discharge sanitary wastewater into the Boulder Zone. This statement should be revised to: "Sanitary wastewater that is discharged at the site is discharged via a Class V injection well to the Biscayne Aquifer..."
(**0017-4-10** [Maher, William])

Response: *Section 4.5.2.2 of the SEIS was revised to correct the description of the sanitary wastewater discharges consistent with the discussion in Section 3.5.1.3 of the SEIS.*

Comment: I saw that it was moderate to small impact. I happen to believe on the groundwater that it's more than small. I think it's at least moderate or more. (**0001-3-1** [Schievelbein, Tom])

Comment: Section 4.5.1.2, Page 4-31. In section 4.5.1.2, the DSEIS analyzes potential new Information on a Category 1 Issue, Groundwater Quality Degradation (Plants with Cooling Ponds in Salt Marshes). On page 4-27, the DSEIS concludes that "this information is both new and significant." Based on this information, the NRC concludes that "the site-specific impacts for this issue at the Turkey Point site are MODERATE for current operations, but will be SMALL during the subsequent license renewal term as a result of ongoing remediation measures and State and county oversight, now in place at Turkey Point." Similarly, the DSEIS in section 4.14 (p 4-98) states "The NRC staff determined that the information was both new and significant for one of the issues, 'Groundwater quality degradation (plants with cooling ponds in salt marshes),' as listed in Table 4-1 and as evaluated in Section 4.5.1.2, 'Groundwater Resources,' of this SEIS."

This conclusion, that the information is significant due to its relevance for consideration of current operational impacts, is a misapplication of NRC rules and guidance. 10 CFR 51.75(d) states that a draft EIS is intended to analyze the environmental effects of the proposed action and "need not discuss other issues not related to the environmental effects of the proposed action and associated alternatives." Under section 1.1 of the DSEIS, the proposed action is for the NRC to determine whether to issue a renewed license allowing an operation for an additional twenty years. NUREG 1555, Supplement 1, Revision 1 makes clear that new and significant information must bear on impacts of license renewal (*The NRC staff must identify any new information on the environmental impacts of license renewal.) While the information identified by the NRC in section 4.5.1.2 is certainly "significant" from a public interest and regulatory standpoint, it is not significant as that term is defined by the NRC for this purpose. The NRC concluded that this information does not paint a seriously different picture of the environmental consequence of the proposed during the proposed action. Therefore, this information cannot be considered "significant" for the purpose of reviewing the continued applicability of a Category 1 issue.

It appears that the NRC agrees with this conclusion because it has not followed the process

established by the Commission for instances where information bearing on the proposed license renewal period is deemed new and significant. As explained by the First Circuit Court of Appeals and by the Commission in its 1996 rulemaking, where the Staff identifies new and significant information bearing on a Category 1 issue, it must notify the Commission and seek a waiver of the rule addressing Category 1 issues.
Massachusetts v. NRC, 522 F.3d 115, 120-21 (1st. Cir. 2008); 61 Fed, Reg. 28467 at 28470.

Because the staff has neither identified new information that has significant bearing on the period of renewed operation nor sought a waiver of 10 CFR 51.71(d), the NRC could add clarity and regulatory consistency by stating that it has not identified new information that has a significant bearing on the proposed period of extended operations. (**0017-4-11** [Maher, William])

Response: *The NRC staff has appropriately considered and evaluated new information in the SEIS consistent with the NRC's "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," NUREG-1437 (NRC 1996, 2013a) and NUREG–1555, Supplement 1, Revision 1, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants" (NRC 2013b).*

Where appropriate, consistent with the cited NRC staff guidance, the staff has performed a plant-specific analysis of new information in the SEIS to determine whether the information is both new and significant, including for the issue, "Groundwater Quality Degradation ('Plants with Cooling Ponds in Salt Marshes')."

As referenced in Section 1.4 of this SEIS and as further described under Sections 1.5 and 1.8 of the GEIS (NRC 2013a), no additional site-specific analysis is required by the NRC staff for a Category 1 (generic) NEPA issue in the SEIS unless new and significant information is identified that would change the conclusions in the GEIS. In the SEIS, the NRC staff is required to address any new and significant information on the environmental impacts of license renewal involving Category 1 and Category 2 issues.

The NRC provides a more detailed definition of new and significant information in Regulatory Guide (RG) 4.2, Supplement 1, Revision 1 (NRC 2013g). New and significant information is (1) information that identifies a significant environmental impact issue that was not considered or addressed in the GEIS and, consequently, not codified in Table B-1, in Appendix B to Subpart A of 10 CFR Part 51, or (2) information that was not considered in the assessment of impacts evaluated in the GEIS leading to a seriously different picture of the environmental consequences of the action than previously considered, such as an environmental impact finding different from that codified in Table B-1. Further, a significant environmental issue includes, but is not limited to, any new activity or aspect associated with the nuclear power plant that can act upon the environment in a manner or an intensity and/or scope (context) not previously recognized.

With respect to new information concerning a Category 1 issue, the NRC staff must evaluate the significance of any changes in the affected environment or in nuclear power plant operations that have occurred since the initial license renewal term as a basis for predicting the potential environmental impacts of continued operations during the subsequent license renewal term. With regard to the cited issue, as described in Section 4.5.1.2 of the SEIS ("New Information, Category 1 Issue, Groundwater Quality Degradation" ("Plants with Cooling Ponds in Salt Marshes"), the staff's findings regarding the significance of the new information and the associated impacts determination of MODERATE for the current license renewal term are *based on the fact that current and ongoing operations have noticeably degraded groundwater quality in the vicinity of the Turkey Point site and contributed to migration of the saltwater interface. Without mitigative actions, continued operations of the CCS will likely result in additional degradation of groundwater quality. In its analysis, which has been revised for clarity in this final SEIS and based on the latest available information including data on CCS freshening and recovery well operations, the NRC staff acknowledges that groundwater remediation activities are now ongoing and have had, and are likely to continue to have, beneficial effects on groundwater quality. Accordingly, the staff's final SEIS projection that the impacts would be "SMALL" during the subsequent license renewal period is based upon the continuance of FPL's ongoing mitigative actions (CCS freshening and plume recovery) and regulatory oversight by the FDEP and the Miami-Dade County DERM, to reduce the effects of past and ongoing operations on groundwater quality and to achieve the remediation standards prescribed by the State and Miami-Dade County. Because the predicted success of the mitigative actions is based on groundwater modeling and regulatory oversight of the responsible State and local agencies, the staff acknowledges as part of its assessment that there is uncertainty as to the level of projected impacts of the proposed action.*

Comment: For decades the antiquated cooling canal system at Turkey Point has been releasing contaminated hyper-saline water into the underlying aquifer. And that's been moving west towards the well fields that supply drinking water for millions and east into Biscayne National Park. This is nothing new, right? So FP&L is currently now working with Miami-Dade County and Florida's Department of Environmental Protection to clean up the pollution and prevent it from recurring in the future. However these remediation efforts have just begun and there's no hard evidence or data at this point in time that conclusively shows that these efforts will be successful. Now FP&L is looking to extend the operating license of its two nuclear units, Units 3 and 4 and by design to continue to operate the cooling canal system. The Environmental Impact Statement that analyzes the impacts of this re-licensing is fundamentally flawed in its conclusions and in the alternatives it considers. The analysis concludes that FP&L should receive a license renewal, which of course assumes that the cooling canal system will continue to operate, because the environmental impacts will be mostly small or occasionally moderate. However, if these conclusions are based on the assumption that FP&L will be successful in meeting the terms of its agreement with Miami-Dade County and with the State of Florida and that pollution from the canals will cease and be cleaned up. It treats this assumption as though it's a foregone conclusion even though it's based only on models provided by FP&L. The remediation efforts that are set to take place over a 10 year time frame only began last year. (**0001-8-1** [McLaughlin, Caroline])

Comment: At this time there is no hard data or evidence that conclusively indicates that FP&L will be successful in cleaning up that pollution. Under a different scenario, what happens if their remediation efforts don't work and the cooling canals continue to pollute the surrounding environment? What would the environmental impacts of that scenario look like? We don't know because an assessment of that scenario is not included in this Environmental Impact Statement. NPCA as an organization strongly hopes that the remediation efforts will in fact be successful. However, until there is strong data or science to back up that assumption, it's absolutely premature for NRC to be issuing the recommendation on whether or not to re-license these units. (**0001-8-2** [McLaughlin, Caroline])

Comment: And specific to ongoing framework development that I mentioned earlier on groundwater in situ and sent to the management of Yellow Cake and different things like that, that would be related here. And I noticed, that based on chronology and statements that are in the abstract, you know, the EPA has wavered on communicating details specific to impact, inputting how to build out that framework. And that's concerning. Because that overlays to basically politic. And if we're building frameworks, they have extend beyond politic or a four year presidential cycle. It has to extend to something that well last over the life of the permit and the guidance. And I see a conflict there with regards to clearly stating that the EPA would give guidance, and then backtracking back and letting the NRC to its own devices, not that you're not more than capable with your environmental staff, but you have an agency for that and I'm wondering why the resource is not being mandated, if not utilized. The same thing, why aren't the resources of modeling being utilized like the agencies that are provided by the acts, that's detailed in acts. (**0001-15-2** [Gomez, Albert])

Comment: But I will mention that prior to the current fix, which is proposed under the consent decree, there's been no less than four previous attempts to operate these canals within the NPDES permit and deal with the leakage and the environmental impacts that it's causing to the water resources. And this has been over the last 20, 25, 30 years and they've all failed. And in this current consent decree is an attempt, again, to implement a fifth fix and if it doesn't work, then after that, FP&L has a chance to try it again, I guess. (**0001-16-3** [Schoedinger, Steven])

Comment: And it's a relief to see this impact statement that doesn't have the direct discharge into the Bay, because that's not acceptable, and you don't think it's acceptable and you shouldn't. But what is not being said here is that these canals are not water from elsewhere. They just dug a hole, a channel into the aquifer. This is the Biscayne aquifer. And what you're doing is you're pumping Biscayne aquifer water around in a big circle. And why that's so weird to be doing, is because the geologic formation here is basically stone swiss cheese. What you have is you have a swimming pool that's about 90 feet deep and it covers many square miles. So the idea here is that you've got water in a channel on the top of a swimming pool that you're moving around for cooling and you're adding contaminants to it. Does it come as any surprise that when you boil the water off, essentially making it evaporate, the salt plume starts going down to the bottom of the aquifer and spreads all through the swimming pool. Of course it did. There were concerns raised at the time, they didn't think that it was really gonna work. And it didn't. So what they did was they came up with a scheme to have an interceptor canal, almost 18 feet deep, 20 percent down to the bottom of the aquifer and 60 feet wide. They were going to pump it out into the groundwater canals to keep the plume from moving. And it didn't work. Five years later it was very clear it didn't work at all, so they -- the Florida Power and Light took the bull by the horns. They renamed the interceptor canal to the interceptor ditch to downplay its failure. And then they produced a series over 35 years, 35 years, a series of models and plans to pump the polluted water around inside the aquifer and stop the contamination from moving. 35 years later the water is still moving at 15 inches per day westward into drinking water aquifers, into drinking water sources. (**0001-17-2** [Guest, David])

Comment: we talked about the many times that FP&L has tried to fix the cooing canal situation with respect to the hyper saline plume, and how every single time it's been unsuccessful. In this case there's no evidence that it's working and that the EIS is premised -- if you read the EIS, that many of the statements that they make and findings they make, are based upon this system working. And you heard from Carolyn McLaughlin who said there was no indication that it was working. In fact, we had a statement by several of the speakers that the plume was moving and there was a new report out on wells that were in the western part and that the plume is moving. (**0002-6-1** [Rippingille, Bonnie])

Comment: FPL operates within Miami-Dade County and has currently entered into a clean up agreement with DERM over the increasing and advancing radioactive high salinity pollution plume. This clean up agreement has not been fulfilled or validated, in fact varying scientific institutions have reviewed FPL's pollution plume clean up methodology and have concluded that it will fail to clean up the pollution plume, therefore advancing more pollution through continued operation of Turkey Point Reactor 3 & 4 will place FPL in breach of the clean up agreement. Re-licensing Turkey Point ahead of the clean up would usurp DERMs authority to regulate and protect our clean drinking water supply. (**0020-7** [Gomez, Albert])

Comment: Also, the NRC is currently adjusting the environmental review frame work for ground water standards. The NRC should not relicense while relevant frameworks are in flux. (**0020-10** [Gomez, Albert])

Comment: For years, the CCS has been contributing to the steady growth of a hypersaline plume, marching west in the Biscayne Aquifer towards our wellfields and east underneath Biscayne National Park. In 2015, after Miami-Dade County issued FPL a notice of violation pertaining to the County groundwater quality standards, FPL entered into a Consent Agreement with the County to abate hypersaline water discharges and remediate the hypersaline plume to the west and north of Turkey Point. In 2016, Miami-Dade County executed an addendum to the Consent Agreement due to apparent violations of County water quality standards related to ammonia exceedances in surface water. As stated above, ammonia exceedances in surface water quality standards attributable to the CCS were detected in 2018, after the execution of the amended Consent Agreement.

In 2016, FPL and FDEP executed a Consent Order related to discharges from the CCS that impaired the beneficial use of Class G-II groundwater adjacent to the CCS, the exceedance of surface water quality standards in Biscayne Bay, and the impact of the hypersaline plume on the saltwater interface. One of the requirements of the Consent Order is for FPL to maintain the average salinity in the CCS at or below 34 PSU. Modeling from 2014 showed that by adding about 14 million gallons per day (mgd) of Upper Floridan Aquifer water with a salinity of 2 PSU to the CCS, it should only take a year to reduce salinities in the CCS to 35 PSU.23 However, in 2016 and 2017, when FPL added approximately 12.8 mgd of Upper Floridan Aquifer water to the CCS, the average salinity was nowhere near 35 PSU. Rather, it was around 65 PSU.24 While FPL has additional time to comply with Consent Order requirements regarding salinity, this example illustrates the uncertainty inherent in modeling exercises.

Uncertain Outcome of Remediation Efforts
In order to meet remediation objectives of both the Consent Agreement and Consent Order, FPL has constructed recovery wells to extract the hypersaline plume from the Biscayne Aquifer, pumping contaminated water into the Boulder Zone. According to remediation objectives, FPL has 10 years to retract the hypersaline plume to the boundaries of Turkey Point. FPL is required to conduct a series of Continuous Surface Electromagentic Mapping (CSEM) surveys designed to illustrate the extent and boundaries of the hypersaline plume. The recovery well system went online in 2018 and has been operational for only one year. The only CSEM data currently available shows baseline data from which the future efficacy of remediation efforts will be measured. At this point there is no concrete data to support the claim that remediation efforts will be successful, or that they will be successful in the 10-year time frame stipulated in the Consent Agreement and Consent Order.

It is important to note the consequences laid out in both the Consent Order and Consent Agreement if FPL is unsuccessful at meeting remediation requirements. If FPL is unsuccessful at meeting the terms of these agreements, they only need to come up with additional remediation plans and strategies to be implemented under an indeterminate timeline. Regarding

CCS salinity requirements laid out by the Consent Order with FDEP:

If FPL fails to reach an annual average salinity of at or below 34 PSU by the end of the fourth year of freshening activities, within 30 days of failing to reach the required threshold, FPL shall submit a plan to the Department detailing additional measures, and a timeframe, that FPL will implement to achieve the threshold. Subsequent to attaining the threshold in the manner set forth above, if FPL fails more than once in a 3 year period to maintain an average annual salinity of at or below 34 PSU, FPL shall submit, within 60 days of reporting the average annual salinity, a plan containing additional measures that FPL shall implement to achieve the threshold salinity level.25

FPL is also required by the Consent Order to implement remediation efforts that will halt the westward migration of the hypersaline plume within three years and reduce the westward extent of the plume to Turkey Point boundaries within 10 years:

iv. To ensure overall remediation objectives are attained in a timely manner, if the second CSEM survey indicates that the net westward migration of the hypersaline plume is not being halted, then, within 180 days of the second CSEM survey, FPL shall develop and submit for approval to the Department a plan with specific actions to achieve the objectives of the remediation project. If the third CSEM survey still indicates the net westward migration of the hypersaline plume has not halted, FPL shall implement the approved additional measures within 30 days after submittal of the third CSEM report to the Department.

v. At the conclusion of the fifth year of operation of the remediation project, FPL shall evaluate and report to the Department, within 60 days, the effectiveness of the system in retracting the hypersaline plume to the L-31E canal within 10 years. If this report shows the remediation project will not retract the hypersaline plume to the L-31E canal within 10 years due to adverse environmental impacts of remedial measures or other technical issues, FPL shall provide an alternate plan for Department review and approval. FPL shall begin implementing the alternate plan within 30 days of receipt of notice that the alternate plan has been approved.26

23 Ibid.[United States Nuclear Regulatory Commission, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 5, Second Renewal Regarding Subsequent License Renewal for Turkey Point Nuclear Generating Unit Nos. 3 and 4, Draft Report for Comment, NUREG-1437 Supplement 5 Second Renewal, March 2019, pg. 3-4, emphasis added.], p. 3-49.
24 Ibid., p. 3-49.
25Florida Department of Environmental Protection, Consent Order with Florida Power & Light Company, OGC File No:16-0241, June 20, 2016, p. 8, 20.a, emphasis added.
26 Ibid., p. 10, 20.c.iv. emphasis added.
(**0023-10** [McLaughlin, Caroline])

Comment: Similarly, FPL's Consent Agreement with Miami-Dade County requires the implementation of a Biscayne Aquifer Recovery Well System (RWS) to intercept, capture, contain, and retract the hypersaline plume. After five years, the effectiveness of the RWS will be evaluated:

If the analysis indicates that the RWS is not anticipated to achieve the goal to intercept, capture, contain, and ultimately retract the hypersaline groundwater plume, FPL shall make recommendations for modifications to the project components and/or designs to ensure the ability of the system to achieve the objectives of the Consent Agreement. The evaluation and any proposed revisions shall be submitted to DERM for review and approval.27

The Consent Agreement stipulates that the effectiveness of the RWS will also be evaluated after 10 years:

If monitoring demonstrates that the activities are not achieving the objectives of this Consent Agreement, FPL shall revise the project components and/or designs to ensure the ability of the system to achieve the objectives of this Consent Agreement. The proposed revisions shall be submitted to DERM for review and approval.28

Thus, if remediation efforts as stipulated by the Consent Agreement and Consent Order prove to be ineffective and fail to meet the regulatory requirements laid out in the documents, the only real consequence is that new remediation plans will be devised and implemented over an even longer timeframe. There are no concrete requirements laid out that would guarantee a cessation of continued pollution by the CCS, such as, for instance, a requirement to decommission the CCS. Rather, the only consequence would be unspecified continued remediation efforts over an unspecified timeframe with uncertain results. It is possible that the westward migration of the hypersaline plume and surface and groundwater quality violations could continue indefinitely, and certainly through the subsequent relicense period.Unfounded Conclusions Regarding Impacts of Proposed Action on Groundwater Resources

In the DSEIS, NRC staff concludes that groundwater quality impacts, "are MODERATE for current operations, but will be SMALL during the subsequent license renewal term as a result of ongoing remediation measures and State and county oversight, now in place at Turkey Point."29 As described above, FPL has a history of violating water quality standards and some of the models predicting the impacts of remediation efforts have already shown to be unsound. FPL has always been responsible for operating Turkey Point under all applicable federal, state, and local laws. That they are currently under State and county oversight does not change their history of noncompliance with applicable regulations. Moreover, models are inherently uncertain. NRC staff acknowledges that, "groundwater models are approximations of natural systems and are dependent on a number of input variables based on assumptions regarding present and future environmental conditions. Thus, they entail substantial uncertainty."30

Despite the uncertainty inherent in modeling, FPL's history of violating water quality standards, and the absence of any concrete evidence or data indicating that remediation efforts will be successful, NRC staff somehow comes to the following conclusion:

As a result of FPL's operation of its recovery well system and continued regulatory oversight and enforcement of the terms of the consent order and consent agreement by the FDEP and DERM, the impacts on groundwater quality from operations during the subsequent license renewal term would be SMALL.31

27 Miami-Dade County Department of Regulatory and Economic Resources, Consent Agreement with Florida Power & Light Company, October 7, 2015, p. 6, 17.b.iii, emphasis added.
28 Ibid., p. 6, 17.b.iv, emphasis added.29 United States Nuclear Regulatory Commission, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 5, Second Renewal Regarding Subsequent License Renewal for Turkey Point Nuclear Generating Unit Nos. 3 and 4, Draft Report for Comment, NUREG-1437 Supplement 5 Second Renewal, March 2019, p. 4-27.

30 Ibid., p. 4-27.
31 Ibid., p. 4-27.32 Applicant's Environmental Report: Operating License Renewal Stage Turkey Point Units 3 & 4 Florida Power &
Light Company; Docket Nos. 50-250 and 50-251 Revision 1, Page 2.2-1.
(**0023-11** [McLaughlin, Caroline])

Comment: As cited extensively above, the Consent Order and Consent Agreement do not guarantee that remediation efforts will be effective. If they are not effective, the only result would be the development of additional remediation techniques, the success of which also cannot be guaranteed. The conclusion that environmental impacts of the Proposed Action on groundwater resources would be SMALL is an unfounded, unsupported, and inaccurate conclusion. It is a very real possibility that remediation efforts will be unsuccessful, and the CCS will continue to discharge pollution into surrounding ground and surface waters, including those of Biscayne National Park. In the DSEIS, NRC staff must include any kind of assessment of the environmental impacts of the Proposed Action if remediation efforts are unsuccessful. (**0023-12** [McLaughlin, Caroline])

Comment: I would like to know when the current contamination of the aquifer will be corrected. (**0027-1** [Dick, Marianne])

Comment: License Renewal Term: As outlined in the comments below, the EPA identified numerous issues from the review of the SD EIS regarding many aspects of the Proposed Action or relicensing renewal. Most significant of these issues is the hypersalinity plume in the aquifer related to the Canal Cooling System (CCS). The EPA notes that the Florida Department of Environmental Protection (FDEP) and the Miami-Dade County Department of Environmental Resources Management (DERM) have entered into various consent agreements with Florida Power and Light (FPL) regarding issues related to the CCS. The EPA supports the FDEP and DERM's efforts to work with FPL to remediate the adverse impacts of the hypersalinity plume in the aquifer and the ammonia releases to surface waters. The EPA notes that these consent agreements have outlined various corrective actions to address the issues related to the CCS. However, these corrective measures have only recently been implemented.

Recommendations: Given the many unknowns related to the CCS corrective measures effectiveness and the timing and length of the license renewal, the EPA recommends the NRC consider a reopening term and/or condition in the license should the corrective measures in the FDEP and DERM consent agreements not be met. As part of this reopening term and/or condition, we recommend that the NRC and the licensee re-evaluate the alternative corrective measures to include the Cooling Water System Alternative. The EPA recommends the NRC, in consultation with FPL, FDEP and DERM, take an adaptive management approach to ensure the facility's compliance with the applicable consent agreements. The EPA further recommends that the NRC coordinate closely with FDEP and DERM to ensure that the FDEP and DERM are sufficiently satisfied with the progress of the CCS corrective measures before the license renewal begins in 2032. (**0031-2** [Militscher, Christopher])

Response: *As described throughout Sections 3.5.1.4 and 3.5.2.2 of the SEIS, which have been revised in this SEIS based on the latest available information, including from annual surface water, groundwater, and ecological monitoring surveys, the staff has considered the development of regulatory actions addressing cooling canal system (CCS) operational effects on groundwater quality and the adjacent surface waters. The staff considered the results achieved to date, the regulatory authority exercised by State and County regulatory agencies, and the likely effectiveness of the mitigative actions undertaken by FPL under the Miami-Dade*

County Consent Agreement and the Florida Department of Environmental Protection Consent Order to remediate the hypersaline plume and reduce the impact of CCS operation on groundwater quality and surface water quality via the groundwater pathway.

In the NRC staff's impacts analysis presented in Section 4.5.1.2 of the SEIS, the staff determined that impacts on groundwater quality are MODERATE for the current license renewal term based on the fact that current and ongoing operations have noticeably degraded groundwater quality in the vicinity of the Turkey Point site and contributed to migration of the saltwater interface. Without mitigative actions, continued operation of the CCS is likely to result in continued degradation of groundwater quality. In its analysis, however, the NRC staff further acknowledges that groundwater remediation activities are now ongoing and have had and are likely to continue to have beneficial effects on groundwater quality.

The staff's impacts projection that the impacts would be "SMALL" during the subsequent license renewal period is based upon the continuance of FPL's ongoing mitigative actions (freshening and plume recovery) to reduce the effects of past and ongoing operations on groundwater quality. Because the predicted success of the mitigative actions is based on groundwater modeling and regulatory oversight of the responsible State and local agencies, the staff acknowledges as part of its assessment that there is uncertainty in the projected impacts under the proposed action. The staff determined in Section 4.5.1.2 of the SEIS that, while there is uncertainty in timing and the ultimate effectiveness of the mitigative actions, the success of FPL's mitigation efforts is subject to regulatory oversight by county and state agencies and is continually evaluated through a comprehensive water quality monitoring program. Section 3.5.2.2 of this SEIS has been revised to reflect the latest published groundwater monitoring data for the Turkey Point site, including the results from the 2018 continuous surface electromagnetic survey designed to track changes in the hypersaline plume, as well as the latest published data on CCS freshening and recovery well operation effectiveness. The NRC staff has considered and acknowledged this new information in its impact assessment as presented in revised Section 4.5.1.2 of the SEIS (see "New Information, Category 1 Issue, Groundwater Quality Degradation" ('Plants with Cooling Ponds in Salt Marshes')) while acknowledging that uncertainty remains. If FPL's monitoring results show that water quality improvements are not being made because corrective actions are not as effective as projected, FPL must develop and submit alternative remediation plans to the regulatory agencies. Because the regulatory oversight is anticipated to remain in place and the regulatory agencies retain the authority to require FPL to continue its current freshening activities, the NRC staff concluded that the proposed action would have SMALL impacts on water resources during the period of subsequent license renewal, despite the existence of uncertainty as referenced above.

With respect to commenter concerns that the NRC should include a reopening clause and/or condition in the renewed reactor operating licenses, if issued, for Turkey Point Units 3 and 4 in the event that FPL is unable to achieve the mandated groundwater remediation objectives, the staff notes that the NRC does not have regulatory authority to require FPL to comply with consent agreements or consent orders issued by the State of Florida's Department of Environmental Protection or the Miami-Dade County DERM, and therefore cannot make compliance with orders issued by other agencies a condition of the NRC license. Miami-Dade County and the Florida Department of Environmental Protection have the authority and responsibility for enforcing applicable provisions of their environmental regulations and the referenced consent order and consent agreement. Issuance of a renewed license, however, does not foreclose or restrict the ability of other regulatory authorities to take such actions as *they deem necessary to ensure compliance with the orders, consent agreements, or other regulatory requirements under their jurisdiction.*

Comment: I have to agree with the representative from the League of Women Voters, and m[M]y other concern has to do with housing. This part of the County is where the greatest growth in housing is occurring in Miami-Dade County, and that's largely driven by the cost of housing everywhere else in the County. And as a consequence you're going to have more people that are going to be relying on electricity and also on water. And it's very important, it's critical that we get this right. I mean we have a plume that is growing about a foot a day, and this has been going on for 30 years, and we need to make sure this is taken care of. And frankly, I think that FP&L should assume the cost in cleaning this up, because they've got the money to do it. (**0001-6-1** [Morra, Frank])

Comment: [The EPA has identified the following issues related to the environmental impact and alternatives analysis as discussed in Chapter 4 of the SDEIS....]
*Minimization of CCS Impacts: Descriptions of the CCS environmental impacts are not provided in a cohesive manner in the SD EIS. An explanation for the characterization approach is found in a table footnote on page 199 of the document (Table 4-1, footnote b, pg 4-4,5):

"(b) The NRC staff recognizes that the current impacts on this issue are greater than SMALL (i.e., the impacts are MODERATE). However, as discussed in Section 4.5.1.2 of this chapter, in response to a 2015 consent agreement with the Miami-Dade County Department of Environmental Resource Management (DERM) (MDC 2015a) and a 2016 consent order from the Florida Department of Environmental Protection (FDEP) (FDEP 2016e), FPL has implemented a recovery well system to halt and retract the hypersaline plume and to abate and remediate the effects of the hypersaline plume.from the cooling canal system. These efforts are expected to remediate the hypersaline plume prior to the commencement of the subsequent license renewal term. In addition, FPL 's actions to remediate the plume are subject to continued regulatory oversight by the DERM and the FDEP. Therefore, the NRC staff expects that groundwater quality degradation impacts resulting.from subsequent license renewal will be SMALL."

The EPA is concerned that the Proposed Action is placed in the "small" impact category. The EPA supports the FDEP and DERM's efforts to work with FPL to remediate the adverse impacts of the hypersalinity plume and ammonia releases. However, there is much unknown regarding the hypersalinity plume and ammonia releases and it is uncertain that these measures will provide the long-term results as modeled. Additionally, the water withdrawal impacts to drinking water sources and the Comprehensive Everglades Restoration Plan projects (CERP) (See comment below) when determining the impact category should be considered.

Recommendation: The EPA recommends the NRC reevaluate the impacts to groundwater by including impacts associated with water withdrawals and evaluating the impacts of the CCS in the existing condition. The EPA recommends the NRC reconsider placing groundwater and surface waters in the "Moderate to Large" impact category. (**0031-5** [Militscher, Christopher])

Response: *The NRC staff evaluated the potential groundwater use conflicts resulting from groundwater extraction for the recovery well system (RWS) and the cooling canal system (CCS) salinity reduction in Section 4.5.1.2 (see "Groundwater Use Conflicts (Plants That Withdraw More Than 100 Gallons per Minute")) of this SEIS. Impacts on the Biscayne aquifer, including on drinking water sources, were determined to be SMALL. RWS groundwater withdrawals* *associated with hypersaline plume recovery and other FPL withdrawals from the saline portion of the aquifer would be unlikely to interact with any offsite wells withdrawing water from the inland portions of the Biscayne aquifer. Offsite reductions in groundwater elevations due to RWS pumping were also evaluated by the staff on the basis of groundwater modeling by FPL and the South Florida Water Management District (SFWMD) and were determined to have minimal potential to impact wetlands to the west of the L-31E Canal. This modeling (Tetra Tech 2016) included the pumping effects of known municipal, industrial, and agricultural wells pumping at their maximum permitted withdrawal rates. The NRC staff considers the modeling assumption that wells would operate at their maximum permitted rates to be conservative and acceptable, considering potential regional population growth and associated water demands during the projected remediation timeframe.*

Groundwater withdrawal impacts on the Upper Floridan aquifer were determined to be MODERATE during the subsequent license renewal term. The modeling analysis considered by the NRC staff (Tetra Tech 2014b) assumed that FPL's freshening wells withdrawing from the Upper Floridan aquifer would operate at maximum permitted rates, combined with other existing permitted withdrawals in the region withdrawing at permitted rates. As for the Biscayne aquifer, the NRC staff also considers the modeling assumption to be conservative and acceptable, considering potential regional population growth and associated water demands.

The NRC staff's response to comments specific to the likely effectiveness of the mitigative actions undertaken by FPL to remediate the hypersaline plume and reduce the impact of CCS operation on groundwater quality and surface water quality is provided in its response to Comment no. **0031-2.**

Comment: Groundwater: Regarding groundwater, the SDEIS provides the following: 3.1.3.2, (pg 3-11). States: "FPL estimates that the inflow of groundwater from the Biscayne aquifer into the CCS is about twice the volume of outflow of water from the CCS into the Biscayne aquifer (FPL 2018f).e"

The EPA is concerned that discussing inflows/outflows apart from concentration can create a potential misunderstanding. To a lay person, a positive inflow/outflow volume ratio may appear to be a 'positive' indicator. However, when considering that dissolved solids are retained apart from volume, this ratio can be problematic. Volume exchange is a factor that must be considered in the system characterization, but it is the total mass and concentrations of dissolved constituents that determine the water quality impacts. The analysis in the SDEIS is lacking these refined distinctions. (**0031-12** [Militscher, Christopher])

Response: *The comment refers to a subsection in Section 3.1.3.2 of the SEIS that describes the operation of the cooling canal system (CCS) in terms of water flows into and out of the CCS. A comprehensive discussion of the water and salt budgets of the CCS, the water quality of the CCS, the transport of dissolved constituents from the CCS to adjacent water bodies, and the management of salinity in the CCS is included in Section 3.5.1.4 of the SEIS. This comment provides no new information, and no changes were made to the SEIS in response to this comment.*

Comment: The two alternatives, especially as it relates to the cooling water systems that are being looked at, which are either cooling towers or to continue with the canals, the open canals that are there. Presently the source of the water for the canals is out of the Floridan, which is brackish water, which contributes somewhere between a million and a half pounds of salt per day into those canals, which is, you know, part of the problem that we're identifying today. Over decades that's generated part of the problem we're dealing with at this point in the admissions to the Bay. If you look at the Floridan going into cooling towers, then you don't deal with the impacts of salt into a body of water that might leach into surrounding resources. It is truly a closed-loop system, and it would, at that point, be used to cool and you'd use much less, because in order to use the canals, out of the Floridan, you have to generate 30 million gallons a day more than you really need for the process to allow for the evaporation that takes place daily over 6,000 acres of these 3-foot deep, 20 and 50-foot wide canals. And that's a horrendous use, a horrible use of water resources for South Florida. We are growing more and more reliant on the Floridan for our drinking water. For example, FKA, a third of the capacity at that plant is an RO plant that takes water from the Floridan in order to serve the Florida Keys. And I think at this point that is a serious resource. We have a drought in North Florida where the Floridan takes it water, you know, then the water levels in the Floridan could drop down to levels which would impact the operation of a lot of water supply, irrigation systems that are being used, and maybe in some case drinking water systems. (**0002-1-1** [Shoedinger, Steve])

Comment: Conflict Analysis: On page 4-30, Conflicts Analysis for the Upper Floridan Aquifer section, the SDEIS discusses the groundwater impacts for the Proposed Action related to FPL's freshening well system and states, "For offsite, non-FPL wells, the model projects a maximum drawdown of 2. 26 feet (0. 7 m) at the MD WSD 's South Miami Heights wellfield, located approximately 10.3 mi (16.6 km) north, northwest of the center point of FPL's freshening well system." The EPA notes that there appears to be no evaluation in this conflict analysis that considers possible impacts to the U.S. Army Corps of Engineers (USACE) or South Florida Water Management District's (SFWMD) CERP projects. Also, there appears to be no water use conflict analysis for the other alternatives (no action, new nuclear, natural gas combined-cycle, combination alternative or cooling water system), which does not adequately portray how the other alternatives would potentially impact groundwater and drinking water resources.

Recommendation: The EPA recommends the NRC conduct a groundwater use conflict analysis for the FSEIS (as described for the Proposed Action, pages 4-28-4-35) and comparatively evaluate each alternative's impacts related to water withdrawals. Furthermore, the EPA recommends the NRC consider the water withdrawal impacts to include impacts to CERP when determining the Proposed Action's groundwater impacts. (**0031-10** [Militscher, Christopher])

Response: *Section 3.5.2.1 of the SEIS describes that the Biscayne aquifer is separated from the Upper Floridan aquifer by the Intermediate Confining Unit, which serves as an effective aquiclude for the Floridan aquifer system. Due to the low permeability of the confining unit, extraction of water from the Upper Floridan aquifer is not expected to affect uses of Biscayne aquifer water, including for projects related to the Comprehensive Everglades Restoration Plan (CERP). As a result, the scope of the NRC staff's groundwater use conflicts analysis in Section 4.5.1.2 (see "Groundwater Use Conflicts (Plants That Withdraw More Than 100 Gallons per Minute")) of the SEIS with respect to FPL freshening operations for the CCS was restricted to users extracting water from the Upper Floridan aquifer. However, the NRC staff's conflicts analysis for the Biscayne aquifer is separately presented in Section 4.5.1.2, which considers the effects of FPL's recovery well system. This analysis considers and quantifies projected impacts on groundwater elevations, offsite sawgrass marsh wetlands, and on existing users of the Biscayne aquifer.*

With respect to alternatives, as described in Sections 4.5.2.2 and 4.5.7.2 of the SEIS for the no-action and the cooling water system alternatives, respectively, the staff expects that groundwater demands for CCS freshening would decrease over time commensurate with the *reduction in thermal discharge to the CCS from Turkey Point Units 3 and 4, so that potential water use conflicts would also be reduced for these alternatives, compared to the proposed action. Because thermal discharges to the CCS would also be reduced for the replacement power alternatives, potential water use conflicts would also be reduced for these alternatives. Sections 4.5.2.2, 4.5.3.2, and 4.5.7.2 were revised where appropriate to provide a discussion of these and related considerations.*

Comment: Groundwater Resources. The DSEIS concludes that the impact of the selected alternative, subsequent license renewal, on Groundwater Resources, specifically groundwater quality degradation, would be SMALL. The NRC in a footnote to Table 4-1 indicates that the impacts "are greater than SMALL (i.e., the impacts are MODERATE)" but further indicates that the groundwater quality degradation will be ameliorated by FPL's implementation of the recovery well system "to halt and retract the hypersaline plume and to abate and remediate the effects of the hypersaline plume" and through FDEP and DERM's continued regulatory oversight and enforcement. a) While DERM will continue its regulatory oversight of FPL's remediation of the hypersaline plume, including any required modification and adaptive management on FPL's part, it should be noted that the groundwater model that formed the basis of the predictions regarding the performance of the recovery well system found that "eastward retreat of the hypersaline interface is not achieved in the deepest portion of the aquifer via this remedial alternative" (see Application of Parameter Estimation Techniques to Simulation of Remedial Alternatives at the FPL Turkey Point Cooling Canal System dated July 2016 and submitted by FPL).
b) The groundwater model was calibrated based on a 10-year sea level rise projection and as such the effectiveness of the recovery well system with respect to the capture and containment of the hypersaline plume (as required in the Miami-Dade County Consent Agreement) based on sea level rise projection beyond 2025 was not evaluated. Given the concerns with the documented groundwater impacts of the Cooling Canal System on water resources in the area, the potential limitations and uncertainty associated with complete remediation of the hypersaline plume, and the challenges and uncertainty over FPL's ability to successfully manage the Cooling Canal System water quality into the future, DERM recommends that NRC staff reconsider its characterization of Groundwater Degradation Impacts as SMALL. (**0022-1** [Hefty, Lee N.])

Response: *As indicated in footnote (b) in Table 4-1 of Section 4.1 of the SEIS, the current MODERATE impacts finding for the issue, "Groundwater quality degradation (plants with cooling ponds in salt marshes)," reflects the staff's impacts assessment with respect to the current affected environment for groundwater quality in the vicinity of the Turkey Point site. However, the NRC staff also predicts the environmental impacts of the agency's proposed action (subsequent license renewal) including the continued operation of Turkey Point Units 3 and 4 beyond the expiration of their current licenses; as discussed in Section 4.5.1.2, those impacts are expected to be SMALL. This second license renewal term would not begin until 2032 and 2033 for Units 3 and 4, respectively.*

In support of the staff's impacts analysis for the proposed action (subsequent license renewal) on groundwater quality presented in Section 4.5.1.2, "Groundwater Resources" (see "New Information, Category 1 Issue, Groundwater Quality Degradation (Plants with Cooling Ponds in Salt Marshes"), of the SEIS, the NRC staff reviewed the information provided by FPL (Tetra Tech 2016) describing groundwater modeling of the recovery well system performance as well as a report prepared by the South Florida Water Management District (SFWMD 2017a).

As noted in the modeling report (Tetra Tech 2016), the model results were compared to results of a continuous surface electromagnetic (CSEM) survey conducted to evaluate the extent of the hypersaline groundwater plume west of the cooling canal system (CCS). As stated in Section 3.5.2.2 of the SEIS, the Miami-Dade County Consent Agreement and the Florida Department of Environmental Protection Consent Order specify the use of CSEM survey results to evaluate the location, volume, and movement of the hypersaline plume. The original CSEM survey discussed in the modeling report indicated that the greatest westward extent of the hypersaline plume is not along the base of the Biscayne aquifer, but in a high-flow zone of the aquifer at a higher elevation. This result has been confirmed by the baseline CSEM survey conducted in March/April 2018. As noted in the model report (Tetra Tech 2016), the groundwater model overestimates the westward extent of the hypersaline plume at the base of the Biscayne aquifer. Based on the NRC staff's review of Tetra Tech (2016), the staff has determined that modeling choices were the likely explanation for this overestimate.

Section 3.5.2.2, subsection "Baseline Groundwater Quality and Changes Attributable to Turkey Point Operations," of this SEIS has been revised to describe the depth dependence of the hypersaline plume based on the CSEM survey results. In addition, Section 3.5.2.2 has been revised to reflect the latest published groundwater monitoring data for the Turkey Point site as well as the latest published data on CCS freshening and recovery well operations effectiveness. The NRC staff has considered and acknowledges this new information in its impact assessment as presented in revised Section 4.5.1.2.

As part of its review, the NRC staff reviewed the FPL modelers' calibration process and assumptions, including those with respect to water levels, as documented in the modeling report for the 10-year simulation periods (2016 through 2025). The NRC staff acknowledges the commenter's statement that the modeling commissioned by FPL does not evaluate the effectiveness of the recovery well system beyond 2025. Nevertheless, FPL is required under the terms of the 2015 Consent Agreement with Miami-Dade County and the 2016 FDEP Consent Order to intercept, capture, and retract the hypersaline plume within 10 years of startup of the recovery well system (i.e., by about 2028 and prior to the start of the proposed subsequent license renewal term). The NRC staff further acknowledges that there is inherent uncertainty in groundwater modeling as well as in future hydrologic conditions given climate change. The staff's evaluation (which has been revised in this final SEIS based on the latest available information, including data on CCS freshening and recovery well operations), acknowledges that ongoing groundwater remediation activities have had and are likely to continue to have beneficial effects on groundwater quality. Accordingly, the staff's final SEIS projection that the impacts would be "SMALL" during the subsequent license renewal period is based upon the continuance of FPL's ongoing mitigative actions (CCS freshening and plume recovery) and regulatory oversight by the FDEP and the Miami-Dade County DERM, to achieve the remediation goals prescribed by the State and County.

Comment: Groundwater Resources - FPL, through guidance by the Florida Department of Environmental Protection (FDEP), uses the presence of tritium to trace water movement from the CCS into surrounding areas. As tritium in natural conditions is expected to be lower than 20 pCi L-1, concentrations in sampled waters indicate higher levels that are attributable to the CCS. Groundwater sampled in a series of wells within the CCS and Card Sound show that concentrations are exceptionally higher than the background level (Figure 1). These extremely elevated levels of tritium are a clear indicator of CCS water infiltration into the bay and ultimately a signal of the adverse impacts the bay is experiencing as a result of operations of the CCS. This is further evident in the elevated groundwater samples concentrations for Total Nitrogen (TN) in Figure 2 and Total Phosphorus (TP) in Figure 3. [view figures in pdf available in NRC

ADAMS at ML19143A166] The Draft SEIS states that new technology established in May 2018 will limit CCS waters to the boundary of the CCS and prevent intrusion into the bay in five to 10 years and as such Groundwater impacts were identified as "small to moderate." Assumptions about the effectiveness of these remediation efforts to make predictions about future conditions introduce uncertainty. Instead, this technology should be tested and the assertion that the hypersaline plume will recede back to the boundary of the CCS should be assessed in the identified five-years. With the high levels of tritium already persisting in Card Sound groundwaters, the NPS recommends changing the impact rating for surface water to "Moderate-Large." (**0005-4** [Vogel, Robert])

Response: *Section 3.5.2.2 of the SEIS describes the current water quality in the Biscayne aquifer, including an increasing vertical trend in tritium activity with depth. Section 3.5.2.2 of this SEIS has been revised to reflect the latest published groundwater monitoring data for the Turkey Point site, the results from the 2018 continuous surface electromagnetic survey designed to track changes in the hypersaline plume, as well as the latest published data on cooling canal system (CCS) freshening and recovery well operations effectiveness. The SEIS describes how the higher density of the hypersaline water from the CCS is expected to preferentially move in the lower intervals of the Biscayne aquifer. The NRC staff concluded that the available tritium data indicate CCS operations have influenced aquifer water quality beneath Biscayne Bay, at least in the deep interval of the aquifer. Section 3.5.1.4 of the SEIS describes surface water quality and notes that tritium measured in adjacent surface water bodies has been very low as compared to the deeper intervals of the Biscayne aquifer both onshore adjacent to the CCS and offshore beneath Biscayne Bay and Card Sound.*

As described in Section 4.5.1.2 (see "New Information, Category 1 Issue, Groundwater Quality Degradation (Plants with Cooling Ponds in Salt Marshes)") of the SEIS, the staff evaluated the impacts on groundwater quality from the past and current operation of the CCS and determined that they are currently MODERATE. However, as part of its impact analysis, the staff also projects the potential impacts of the proposed action (subsequent license renewal), including the continued operation of Turkey Point Units 3 and 4, for the 20-year period following 2032 and 2033. As discussed in Section 4.5.1.2 of this SEIS, the NRC staff determined that the impacts on groundwater quality for the proposed action would be SMALL. The NRC staff acknowledges the NPS's concerns regarding the uncertainty in making predictions about the effectiveness of remediation technologies currently being used by FPL, which have been reflected in Section 4.5.1.2 of this final SEIS. However, as discussed in Section 4.5.1.2, which has been updated based on the latest published information presented in Section 3.5.2.2, the staff's impact conclusion is based on consideration of the existing groundwater resource conditions, the current efforts to mitigate the effects of the CCS, and the existing regulatory oversight by State and County agencies. The staff's impacts projection during the subsequent license renewal period is based upon the continuance of FPL's ongoing mitigative actions (freshening and plume recovery) and continued oversight by State and County regulatory agencies (with the authority to impose alternate methodologies, if necessary), to reduce the effects of past and ongoing operations on groundwater quality. The staff determined that, while there is substantial uncertainty in timing and the ultimate effectiveness of the mitigative actions, the mitigation is subject to regulatory oversight by County and State agencies and is continually evaluated through a comprehensive water quality monitoring program.

Comment: [Turkey Point's cooling canal system has been leaking nutrient-rich hyper-saline water into surrounding waters for over 30 years, dumping 3 million pounds of salt per day] into

.... Biscayne aquifer. As a result.... 50 percent of Biscayne aquifer have been destroyed. To repeat, Biscayne aquifer is Miami-Dade's only source of drinking water. FP&L Turkey Point has now applied for a permit renewal that will add another 30 years to their right to pollute the waters of South Florida. It is estimated that if FP&L Turkey Point continues operation of its cooling canals our drinking water supply would be unusable with 5 to 20 years. (**0001-4-3** [Pierce, Barbara])

Comment: It's very clear that to the west -- and by the way, I've just looked at the well data to the west. There is Florida Keys Aquaduct Authority that has several wells that track the movement of this plume. I just looked them up. The well that they put in recently, last year, Well 14 has shown that within a year, the plume has moved beyond that well. They just put it in and they put it in a location where the plume was not there. And if you know anything about science, you know that ionic concentrations of high concentration move to a lower concentration. So this plume will not stop moving. 15 million gallons a day of extraction wells is not going to stop it. That's a fact. It just can't. It will go until the [salt] in concentration settles out. And where is that? The Everglades. It's going to keep moving west. Now one of the solutions in the remediation plan is to add a whole bunch of fresh water to the cooling canal system. If you do that, you increase the driving head of the cooling canal system and what will happen is more of the time it will seep out everywhere around us, flushing the pollution everywhere around us. (**0001-13-3** [Reynolds, Laura])

Comment: And so the nutrients that were left behind formed a toxic hypersaline plume as well as fueled the growth of algae and all of that is going west and going east. West through the aquifer, our sole source of drinking water and down through the limestone and into the Bay, when it's not washing over due to storms or tidal surges.
Anyway FPL is using water that should instead be used for critical Everglades restoration. Our Floridan supply of water in that Floridan aquifer, it's brackish water, it's not unlimited. It's fueled and recharged by water, rainfall from Northern Florida and Georgia. If it doesn't rain, it doesn't get refueled. So it's not unlimited.
The Biscayne aquifer, for your information, has already been allocated to agencies, Governmental agencies, different users, commercial users. It's not being allocated anymore. So the Floridan is the backup to that and the Floridan has to go through an RO process. And one of our speakers today from the North Utility District will talk to you about that. He's an expert in that system. (**0001-14-4** [Rippingille, Bonnie])

Comment: Anyway, as Laura Reynolds said, the pumping of all this massive amount of water, into the cooling canals, has caused a surge. And as she said, I got the same information and actually I got it from her, the wells west now are showing that the plume is moving, which is shocking because we were told that they didn't have any evidence that it was not moving. I'm not saying they were misrepresenting, because the evidence just came in. But the point is, the plume is moving and this system as Ms. McLaughlin told you, is not working and no one expects it to work. This is FPL modeling, this is FPL stalling because they don't want to tie into their profits and have to put these cooling canals (sic) in. They know that they're appropriate. Trust me, they know. And they don't want to do it. And in this process that's going on, over 35 years, starting in 1982, FPL has tried no less than five fixes on this plume situation and this seepage and leakage. And none of them have worked. Now they're into the sixth fix and it's an experimental line of 10 extraction wells along the western side of the five mile link to the canal system, trying to pull back and stop the polluted hyper-saline water after it leaks into the aquifer. They're not pulling it out of the cooling canals, they're pulling it out of the aquifer after it has been permitted over 30 years to leak into the aquifer. Also, they've been permitted to draw all this water from the L-31, the brackish water in the Floridan, and I've already told you that's not an unlimited supply. (**0001-14-6** [Rippingille, Bonnie])

Comment: [Turkey Pont's cooling canal system has been leaking nutrient-rich hyper-saline water into Biscayne ...] aquifer for over 30 years... and 50 percent of Biscayne aquifer have been destroyed. For over 30 years FP&L has been quietly dumping 3 million pounds of salt per day into Biscayne Bay and aquifer. Biscayne aquifer is Miami-Dade's only source of drinking water. FP&L has now applied for a permit renewal which will add another 30 years to their permit to pollute, taking them to the year 2050. It is estimated that if FP&L Turkey Point continues operation of their cooling canals, our drinking water supply will be unusable within 5 to 20 years. (**0002-2-3** [Gutierrez, Vivian])

Comment: These canals are in the aquifer, they're in the Biscayne aquifer. So what you put in there goes into the groundwater. And you hear all these stories we've heard today; people referring to these things as a closed-loop system. It's not. These are canals in the aquifer. And as you heard earlier you have about 3 million pounds a day of salt going through into the aquifer. Even FPL, which is known to stretch the truth pretty thin, even they acknowledge 660,000 pounds of salt goes into the aquifer every day from operating this system. It's not closed loop. It's aquifer contamination and it's moving at 15 inches a day. We've had five previous plants [plans] based on FPL modeling that would stop the salt plume. All five failed completely. It's been moving at 15 inches a day for 35 years. And the new plant, number 6 model, has what is absolutely necessary for them in it, which is a promise that if this plan fails, like the previous five did, that they'll produce another one. That's the obligation is to just keep on doing experiments. And with the level of contamination we have now, I think the time for experimentation has ended, and indeed ended long ago. (**0002-4-1** [Guest, David])

Comment: So the future water supply to continue operating this plant is very important to think about. And I would argue that generally using nuclear power is a bad choice because of its water demands for South Florida. (**0002-5-4** [Reynolds, Laura])

Comment: The cooling canals are only about two feet above sea level and it's dramatically reducing the amount of available fresh water in the Biscayne aquifer because of salt water intrusion. And that's a real problem for this community in South Florida because we are growing. We are growing and we're going to be continuing to grow, by the looks of it. I know all of you experienced the traffic coming here, and know what it's like to try to even get to work in Miami-Dade County. (**0002-6-3** [Rippingille, Bonnie])

Comment: Contaminated water from Turkey Point's antiquated cooling canal system has been seeping into the groundwater and polluting surface waters connected to Biscayne and the aquifer that supplies drinking water for millions. (**0003-2** [Commenters, Multiple])

Comment: I live in Key Largo, FL in Monroe County which is down wind and down stream from FPL's Turkey Point Nuclear Power Plant. I am quite concerned and worried about their application to renew and extend their operating license on their aging power plant. I am aware of the hypersaline plume that extends from Turkey Point's antiquated and dysfunctional cooling canal system. This plume is the single most damaging source of groundwater pollution threatening Monroe County's drinking water supply. The plume also intrudes into Biscayne National Park and threatens the health of the wildlife and habitat that the park is meant to protect.. (**0004-1** [Moses, Dorothy])

Comment: Failure of Turkey Point's Industrial Wastewater Facility Cooling Canal System

Turkey Point is unique among nuclear plants in the United States in that it uses a system of unlined cooling canals to cool water from plant operations. The CCS, in place for more than 40 years, consists of approximately 5,900 acres of former wetlands along the coast of Biscayne Bay and Biscayne National Park. It is used to cool water from nuclear power Units 3 & 4 and to dispose of wastewater from the operations of natural gas Unit 5. When the system was constructed under a 1971 consent decree, the CCS was intended to be a closed loop system. However, due to South Florida's porous limestone geology, the CCS is hydrologically connected to the underlying Biscayne Aquifer and to surrounding surface waters.6

Over the years, water in the CCS has become hypersaline, increasing in density and sinking into the underlying Biscayne Aquifer, ultimately creating an underground hypersaline plume. The plume is spreading out into the Biscayne Aquifer "at an average rate of migration to the west estimated between 525 (northern part) and 660 (southern part) feet per year,"7 towards several wellfields that supply drinking water to the residents of the Florida Keys and southern Miami-Dade County. The plume is also moving east, under the waters of Biscayne Bay and Biscayne National Park.
6 Hefty, Lee, Miami-Dade Department of Environmental Resources Management, Letter to Phil Coram, Florida
Department of Environmental Protection, November 26, 2014.
7 Florida Department of Environmental Protection Administrative Order in Re: Florida Power & Light Company, Turkey Point Power Plant, DEP State License No. PA03-45, OGC No. 14-0741, December 23, 2014. (**0023-4** [McLaughlin, Caroline])

Comment: We can't afford to have more groundwater polluted. (**0046-1** [Champy, Cheryl])

Comment: Turkey Point is a danger South Florida now and plans need to be made soonest to alleviate ground water contamination[.] (**0076-1** [Wesolowski, Pam])

Comment: I am concerned that our ground water be protected for our future generations. (**0109-1** [Luzum, Rosemary])

Comment: As a frequent visitor to the area, I have grave concerns about this ongoing contamination of groundwater. Please solve this issue before extending the life of this facility. (**0145-1** [Hangartner, Terry])

Response: *The impacts to groundwater and surface water resources are described extensively in this SEIS. For example, Section 3.1.3.2 of this SEIS describes the design and function of the cooling canal system (CCS) at Turkey Point. Groundwater resources are described in Section 3.5.2 of the SEIS, including the hydrologic connection between the CCS and the Biscayne aquifer, the current location and rate of movement of the saltwater interface in the groundwater, the effects of the CCS on groundwater quality, regulatory actions to restore groundwater quality, and FPL's groundwater use for CCS freshening and other uses at the Turkey Point site. Portions of Section 3.5.2 have been revised to provide additional information in response to specific comments on the draft SEIS. Specifically, Section 3.5.2.2 has been revised to reflect the latest published groundwater monitoring data for the Turkey Point site, the results from the 2018 continuous surface electromagnetic survey designed to track changes in the hypersaline plume, as well as the latest published data on CCS freshening and recovery well operations effectiveness. Section 4.5.1.2 of the SEIS describes the NRC staff's evaluation* *of the impacts of the proposed action on groundwater quality and potential groundwater use conflicts. Sections 4.5.1, 4.6.1, and 4.7.1 discuss, respectively, impacts to water resources adjoining the Turkey Point site, as well as terrestrial and aquatic resources, including resources within Biscayne National Park.*

These comments provide no new information, and no changes have been made to this SEIS as a result.

Comment: The League [of Women Voters of Miami-Dade County], together with other community leaders, has been following FPL's persistent attempts to renew its Turkey Point cooling canals permit for more than vias now. We're deeply concerned by the environmental and economic impact these cooling canals are having on Biscayne Bay and on Biscayne aquifer, Miami-Dade's only source of drinking water. Even more concerning is FP&L's apparent lack of concern for the health and welfare of the community and its own customers. (**0001-4-1** [Pierce, Barbara])

Comment: I'd like to say that although FP&L claims it's addressing the leakage, the past five and the current sixth plan that they're using has not addressed the source of the problem and that's the flawed cooling canal design. (**0001-9-4** [Bloom, Mary])

Comment: But when looking at these cooling canals, and the degradation of the Bay and the aquifer, we have to remember that so many people in Monroe County, which includes all of the Florida Keys, are going to be terribly impacted if the cooling canals continue to operate. So please, we need to revisit your statement on that. (**0001-9-5** [Bloom, Mary])

Comment: We at the League, together with other community leaders from the County, have been following FPL's persistent attempts to renew their Turkey Point cooling canals permit for over two years now. We are deeply concerned of the environmental and economic impact these cooling canals are having on Biscayne Bay and our fresh water drinking supply, Biscayne aquifier. Even more concerning perhaps is FP&L's lack of concern for the health and welfare of our community and our customers, which grant them access to a very profitable business and location. (**0002-2-1** [Gutierrez, Vivian])

Comment: [As an environmentalist and wildlife advocate, I am very concerned about the operation of of the nuclear power plant at Turkey Point. There should be concrete measures addressing . . .] the contamination that seeps from Turkey Point. (**0008-2** [Propen, Beverly])

Comment: For years, contaminated water from Turkey Point Nuclear Power Plant's antiquated cooling system has been seeping into the groundwater, polluting surface waters connected to Biscayne National Park and the aquifer that supplies drinking water for nearby communities. (**0011-1** [Puca, Rob])

Comment: The TP plant was designed in the 60s with a unique cooling system of approximately 10 square miles of open, unlined cooling canals which use water to cool the reactors. The TPP site and cooling canal system are adjacent to the surficial Biscayne Aquifer, our designated sole source drinking water aquifer and situated between the Everglades National Park, the designated Outstanding Federal Waters of the US, the Biscayne National Park and Card Sound. The open cooling canal system (CCS) was an experiment and is an antiquated system that has not worked as designed for approximately 30 years. The unlined cooling canals are licensed by the State of Florida as an industrial wastewater site. The hyper saline plume created by the FPL operation of the cooling canal system was caused by the 40 mgd of evaporation of water from the open canals which left millions of gallons of heavier salt behind in the bottom of the canals. The hot polluted hyper saline water (3 times saltier than seawater) in the cooling canals has caused the sea grass to die in the canals, which leaving a polluted mix of nutrients and decaying organic matter in the CCS that has interfered with the ability of the water to cool the reactors during periods of intense heat. Now, the system cannot be operated safely without the infusion of 30 million gallons of brackish water daily from our secondary aquifer, the Floridan, to freshen and dilute the salt concentration in the CCS. The CCS water is still hypersaline although the level of salinity has been reduced. Over the course of approximately 35 years, starting in about 1982; FPL has tried five times to resolve the issues caused by the cooling canals, but none of these proposed solutions have worked. At the present time, FPL is attempting a 6th fix which is a line of 10 extraction wells, along the western side of the 5 mile length of the canal system, to attempt to pull back the polluted hyper saline water after it leaks into the aquifer and to stop and pull back the hyper saline plume which extends out more than 4 miles in al! directions from the cooling canals. The hypersa/ine plume is still moving towards Monroe County water well field to the West of the TPPP. Now into the second year of operation , there is no evidence that the hyper saline plume has been stopped. Recently, FKAA scientist Kirk Martin provided us with monitoring well reports demonstrating that the hyper saline plume is still moving westward. (**0024-3** [List, Gary])

Comment: Nobody, animal or human, should have to worry about the safety of their drinking water! (**0110-1** [Sieger, Brenda])

Comment: Logic dictates that protection of human health and the water supply for hundreds of thousands of people must be the priority concern. (**0147-1** [Farber, Carol])

Comment: As a National Park lover and also one who appreciates clean drinking water, it's important to me that we protect our parks and our waters. (**0154-1** [Harris, Susan])

Response: *These comments express concerns regarding the effects of the cooling canal system on water supply and water quality, similar to several comments addressed above. The NRC staff considered the issues identified in these comments, among other matters, in this SEIS. Section 3.5 of the SEIS describes the water resources of the Turkey Point site including the current water quality of the CCS and surrounding surface- and groundwater-bodies. As described in Sections 3.5.1.4 and 3.5.2.2 of the SEIS, the staff considered the development of regulatory actions addressing CCS operational effects on groundwater quality and the adjacent surface waters. The staff also considered the likely effectiveness of the mitigative actions undertaken by FPL under the Miami-Dade County Consent Agreement and the Florida Department of Environmental Protection Consent Order to remediate the hypersaline plume and reduce the impact of CCS operation on water quality. The staff evaluated the potential water resources-related impacts of renewing the Turkey Point Units 3 and 4 operating licenses in Section 4.5. In preparing this final SEIS, the NRC staff reviewed information that became available after publication of the draft SEIS, including ongoing water quality monitoring data, additional environmental studies, and evolving regulatory actions to include information on FPL's progress in achieving the objectives related to the aforementioned State and County regulatory requirements. In addition, the staff incorporated recent information in the final SEIS, as appropriate.*

These comments provide no new information, and no changes have been made to this SEIS as a result.

Comment: [With more time, the NRC and associated regulatory agencies can review new information on] New fresh water well contaminations that occurred since the SEIS was completed (**0020-2** [Gomez, Albert])

Comment: [With more time, the NRC and associated regulatory agencies can review new information on...] Documented illegal salt dumping south of Turkey Point which has created contaminated ground water, more dead zones and is in violation of environmental regulations (**0020-4** [Gomez, Albert])

Response: *In preparing this final SEIS, the NRC staff reviewed information that became available after publication of the draft SEIS, including ongoing water quality monitoring data, additional environmental modeling studies, and evolving regulatory actions. In addition, the staff incorporated recent information in revisions to the SEIS, as appropriate. For example, Section 3.5.2.2 of the SEIS has been revised to reflect the latest published groundwater monitoring data for the Turkey Point site, the results from the 2018 continuous surface electromagnetic survey designed to track changes in the hypersaline plume, and the latest published data on CCS freshening and recovery well operations effectiveness. New reference documents are listed in Chapter 6 of this SEIS. No new information is provided by these comments, and no specific changes have been made to the SEIS as a result.*

Comment: Section 4.5.2.2, Page 4-35. In the DSEIS Section 4.5.2.2 and 4.5.7.2 discussions of the water resource impacts of the No-Action and Cooling Water System alternatives, the DSEIS acknowledges that the CCS would remain in place, albeit with reduced thermal input and a corresponding reduced demand for freshening water additions from the UFA. FPL notes that with these alternatives, the hypersaline plume would also remain and still require operation of the Recovery Well System and disposal through deep well injection in accordance with the Consent Order and Consent Agreement. (**0017-4-12** [Maher, William])

Response: *Sections 4.5.2.2, 4.5.3.2, and 4.5.7.2 of the SEIS that describe the impacts to groundwater resources under the no-action alternative, replacement power alternatives, and cooling water system alternative, respectively, have been revised for clarity to include the addition of a discussion of freshening water additions and recovery well and deep well system injection operational considerations.*

Comment: We currently have 197 members who not only fish in the Bay waters surrounding Turkey Point but also reside in Monroe County and are dependent on the Biscayne Aquifer as our primary source of drinking water. We are concerned about the license renewal for Turkey Point as regards the continued use of the cooling canals as the system to cool the nuclear reactors rather than requiring FP&L to build cooling towers which are recognized by the nuclear industry as the best technology for cooling said reactors. The canals lie above the Biscayne Aquifer and have been leaking pollution into the Aquifer and the waters of Biscayne Bay National park for decades. (**0032-1** [Bloom, Mary])

Response: *Section 3.5.2.2 of the SEIS describes the current water quality in the Biscayne aquifer, and Section 3.5.2.3 describes current groundwater use for operation of Turkey Point and other users in Miami-Dade County. Sections 4.5.1 and 4.7.1 of this SEIS evaluate the impacts of the proposed action (subsequent license renewal of Turkey Point Units 3 and 4) on water resources and aquatic resources, respectively. Further, as described in Section 4.5.1.2 of the SEIS, which has been revised in consideration of the latest available information, the staff* *evaluated the impacts on groundwater quality from the past and current operation of the CCS and determined that they are currently MODERATE. However, the staff also evaluated groundwater quality impacts during the proposed subsequent license renewal period and concluded that these would be SMALL. The staff's impact conclusion was based on consideration of the existing groundwater resource conditions, the current efforts to remediate impacts to groundwater, and the existing regulatory oversight by State and County agencies.*

With regard to FPL's continued uses of the CCS under the proposed action (subsequent license renewal), this SEIS evaluates an alternative closed-cycle cooling water system that could mitigate potential impacts associated with the continued use of the existing CCS. The purpose of this analysis is for the NRC staff to compare the closed-cycle cooling alternative with the proposed action to inform NRC's licensing decision, as well as to inform other decisionmaking authorities and the public, in accordance with NEPA.

The NRC's statutory mission is to protect public health and safety from the effects of radiation from nuclear reactors, materials, and waste facilities. A discussion of these responsibilities beginning with the Atomic Energy Act of 1954 can be found on the NRC Web site at http://www.nrc.gov/about-nrc/history.html. The NRC does not have the authority to require its licensees to utilize a particular type of cooling system, nor can the NRC ensure a licensee's compliance with other regulatory authorities' requirements under the Federal Clean Water Act or with applicable State water quality standards. Accordingly, the NRC does not have the regulatory authority to require that FPL implement an alternative closed-loop cooling water system as a condition of subsequent license renewal.

These limitations on the NRC's authority do not foreclose or restrict the ability of other regulatory authorities to take such actions as they deem necessary to ensure compliance with orders, consent agreements, or other regulatory requirements under their Clean Water Act or other lawful statutory jurisdiction.

No changes were made to the SEIS in response to this comment.

A.2.12 Surface Water Hydrology and Quality

Comment: Section 3.5, Page 3-45. The DSEIS states, "According to its environmental report for subsequent license renewal, FPL's current plans to lower CCS temperatures do not include the use of freshwater from State canals (FPL 2018f). In the future, should FPL need to use freshwater from State canals, FPL would need to seek permission to do so from State and county governments. FPL states that future plans to reduce CCS temperatures include adding brackish water from the Upper Floridan aquifer, reducing algae in the CCS, continuing to remove sediment within the CCS, and, only in extraordinary circumstances, pumping saltwater from the Biscayne aquifer into the CCS (FPL 2018f)." This statement is incomplete because the mitigation activities described are primarily to address salinity in the CCS, not temperature. However, there may be some secondary benefit of temperature reduction that is not reflected in this section. This statement should be revised to: "FPL states that future plans to improve water quality include adding brackish water from the Upper Floridan aquifer, reducing algae in the CCS, continuing to remove sediment within the CCS, and, only in extraordinary circumstances, pumping saltwater from the Biscayne aquifer into the CCS (FPL 2018f)." (**0017-1-19** [Maher, William])

Comment: Section 3.5, Page 3-47. The DSEIS states, "To help reduce the water temperatures within the CCS, on June 27, 2014, the State of Florida granted FPL permission to add saltwater from the Biscayne aquifer and brackish water from the Upper Floridan aquifer to the CCS (NRC 2016a)." This statement is inaccurate because temperature reduction was not the primary objective of the water additions authorized by the State of Florida on June 27, 2014. The supplemental water supplies were used to improve water conditions in the CCS, primarily to lower CCS salinity and temperature. While decreasing salinity levels within the CCS was the primary objective, a secondary benefit may have provided some heat reduction to the CCS. This statement should be revised to: "To help improve water conditions within the CCS, on June 27, 2014, the State of Florida granted FPL permission to ...". (**0017-1-20** [Maher, William])

Response: *Section 3.5.1.4 of the SEIS has been revised, in part, as a result of these comments, to clarify the primary purpose of adding lower-salinity water to the CCS.*

Comment: Section 3.5, Page 3-49. The DSEIS states, "In 2014, Tetra Tech used numerical models to estimate the volume of Upper Floridan aquifer water that would be required to reduce CCS water salinity to seawater range. The modeling exercise produced an estimate that with the addition of 14 mgd (53,000 m3/day) of Upper Floridan aquifer water that had a salinity of 2 PSU it would require less than a year to reduce salinities in the CCS to 35 PSU (Tetra Tech 2014a). However, while FPL then added an average of 12.8 mgd (48,500 m3/day) of Upper Floridan aquifer brackish water to the CCS from the beginning of November 2016 to the end of May 2017, salinities in the CCS did not go down to 35 PSU (FPL 2017a). Rather, at the end of May 2017, average salinity concentrations in the CCS were 64.9 PSU (FPL 2017b)." This statement is ambiguous because it raises questions regarding the volume of Upper Floridan water needed to achieve the targeted annual average salinity of 34 PSU in the CCS. The modeling efforts that are discussed in the Tetra Tech 2014a memo were based on 22 months of data, one year of which had above normal rainfall. As a result of continued monitoring, the model has been updated and further refined using a longer data record that incorporates a more representative range of hydrologic and salinity conditions. The refined model identified a longer period of time would be needed to reduce the average annual CCS salinity in the event of extended dry period or drought. Information from this expanded model was considered by the FDEP in requiring FPL to achieve the average annual salinity of 34 psu in the CCS within four years of initiating freshening activities as described in the Consent Order. The 2017 and 2018 annual monitoring reports both described drier than normal conditions with January through May 2017 being the 6th driest dry season over the previous 49 years and January through March 2018 being the driest in 10 years. If wetter than normal conditions (similar to those that occurred in 2012) persisted, 14 MGD of Floridan aquifer water would achieve the target. However, based on the updated modeling that reflects normal to extended dry conditions, the time needed to achieve the target salinity is longer and even that longer modeled period would be predicated on wetter conditions than the dry conditions experienced in 2017 and early 2018. This statement should be clarified by adding: "Additional data collected since 2014 have been used to update the model with a wider range of hydrologic conditions and associated CCS salinity responses. The updated modeling indicates a wider range of evaporative conditions exist, particularly during the dry seasons, which exceed 14 mgd and suggest that when such drier conditions occur, more freshening water or longer timeframes will be needed to offset the drought related evaporative losses from the CCS." (**0017-1-21** [Maher, William])

Response: *Section 3.5.1.4, "Application of Numerical Modeling to CCS Salinity Mitigation," of the SEIS has been revised, in part, as a result of this comment, to clarify that if drier conditions* *were to prevail, more freshening water or longer timeframes may be needed to mitigate elevated CCS salinities.*

Comment: Section 3.5, Page 3-50. The DSEIS states, "Sampling data by Miami-Dade County and FPL in the late fall and winter months of 2015-2016 revealed levels of ammonia concentration that exceeded the County's water quality standard for ammonia (0.5 mg/L) at two surface water quality monitoring stations near the CCS in Biscayne Bay (MDC 2016a)." This statement is inaccurate because the monitoring stations referred to in this section are not located in Biscayne Bay. They are located in remnant deep-cut man-made canals adjacent to Biscayne Bay. Following an evaluation of those data and data collected in Biscayne Bay conducted by the FDEP, the FDEP determined that no exceedances of State or federal surface water quality standards were detected in Biscayne Bay monitoring (FDEP, 2016e). Miami-Dade County has established its own standard for ammonia as nitrogen under municipal code (Chapter 24, Article III, Division3, Section 24- 44.(2)(f)(v) MDC Municipal Code). The rule identifies the basis of the promulgated ammonia numeric standard as respiratory. This statement should be revised to: "Sampling data by Miami-Dade County and FPL in the late fall and winter months of 2015-2016 revealed levels of ammonia concentration that exceeded the County's water quality standard for ammonia (0.5 mg/L) at two surface water quality monitoring stations near the CCS in bottom samples collected in remnant deep (>20 feet deep) man-made canals adjacent to Biscayne Bay (MDC 2016a). FDEP evaluated those data and additional water chemistry data collected in Biscayne Bay and determined no exceedances of State or Federal surface water quality standards were detected in Biscayne Bay monitoring (FDEP, 2016e)." (**0017-1-22** [Maher, William])

Response: *Section 3.5.1.4 of the SEIS has been revised, in part, as a result of this comment, to clarify the location of the surface water quality monitoring stations and FDEP's determination regarding the exceedance of water quality standards during the 2015-2016 monitoring period.*

Comment: Section 3.5, Page 3-68. The DSEIS states: "In July 2017, Miami-Dade County requested that FPL collect additional data in support of the ammonia site assessment report (FPL 2017b). In November 2017, FPL responded to the County's request by submitting supplemental information." This statement is incomplete because it does not include the significant findings from FPL's November 2017 supplemental information submittal (FPL letter dated November 13, 2017 - Florida Power & Light Company Site Assessment Report Supplemental Information Submittal: DERM File Number HWR 851; available on the FPL SLR online reference portal by May 31, 2019). That submittal documents data and research demonstrating the CCS has little potential for contribution to the ammonia levels in deep canals and identifies sources and process by which ammonia occurs at the monitoring sites. This statement should be revised to include the following information (taken from FPL's November 2017 response): "The FPL response evaluated tritium results from the ten sites identified in the County's April 20, 2017 email combined with data provided from six sites analyzed by MDC DERM to assess the strength of relationship between tritium levels and ammonia measured in surface and groundwater sites. Tritium data were also used to estimate percentage contributions of Cooling Canal System (CCS) waters at the MDC specified surface and groundwater sites to evaluate the degree to which organic nitrogen in and beneath the CCS could account for the ammonia values measured at each site. Ammonia data collected from background porewater monitoring sites located outside the influence of CCS waters from freshwater marsh and coastal brackish water mangrove wetlands was also presented. These data document elevated ammonia levels consistently above County standards that forms from organic nitrogen released from plant debris and organic soils. Additional data and reports were also provided regarding numerous other monitoring stations within the Biscayne Bay coastal area that have documented similar ephemeral excursions of ammonia greater than 0.5 mg/L to those recorded in stagnant deadend canals outside of the Turkey Point facility. FPL concluded these data and analyses support the original conclusions in the Site Assessment Report that the source of the ammonia in the area of Turkey Point is attributable to the degradation of plant and animal material and to natural and anthropogenic phenomenon related to non-CCS factors affecting Biscayne Bay. The elevated ammonia levels in surface waters surrounding the Plant are of limited vertical, spatial and temporal extent. The results obtained from the sampling program at Turkey Point are consistent with data collected throughout Biscayne Bay in other studies along coastal Miami-Dade and Monroe counties. Elevated ammonia values in excess of County surface water standards are not the result of point or non-point source contamination attributable to the Turkey Point Power Plant site and CCS. Rather, the occurrence of elevated ammonia is the result of the conversion of organic nitrogen sourced from organic wetland soils, decomposition of wetland and aquatic plant material, atmospheric nitrogen fixation and natural microbial processes in anoxic, stagnate surface and groundwater environments." (**0017-2-3** [Maher, William])

Comment: Section 3.5, Pages 3-68 and 3-69. The DSEIS states: "The County's letter directs FPL to undertake a number of additional actions, including development of a revised sampling plan for ammonia in surface water and groundwater and measures to reduce nutrient impacts from the CCS on surface waters and groundwater (MDC 2018a). Surface water sampling results from the ammonia site assessment report are discussed in Section 3.5.1.4, "Adjacent Surface Water Quality and Cooling Canal System Operation,"of this SEIS." This statement is incomplete because it does not address FPL's October 8, 2018 response, (a copy of which FPL provided to the NRC in Enclosure 2 to FPL letter L-2019-031 dated April 3, 2019 (ADAMS Accession Nos. ML 19095B380 and ML19095B384). This statement should be revised to: "On October 8, 2018, FPL responded to the MDC July 18, 2018. In their response, FPL noted that groundwater data collected since 2010 from stations surrounding the CCS show, groundwater ammonia concentrations were consistently below MDC Chapter 24-44 Clean-up Target Levels (CTLs) (Section 24-44.(2)(f)(v) of the Code of Miami-Dade County) and as such, provide an acceptable level of protection for human health, public safety and environmental resources and are below the point at which a site rehabilitation action is determined to be accomplished (Section 24-44.(2)(a) of the Code of Miami-Dade County). Further, the average ammonia levels within the CCS canals are well below Chapter 24-42(4) surface water standards of 0.5 ppm (Enclosure 2 to FPL letter L- 2019-031 dated April 3, 2019 (ADAMS Accession Nos. ML 19095B380 and ML19095B384). Measured ammonia concentrations in several of the deep samples greatly exceeded the total nitrogen concentrations in the CCS and in groundwater beneath the CCS demonstrating that there are sources of nitrogen other than the CCS causing exceedances of county ammonia standards in the bottom of the deep canals. As identified in FPL's Site Assessment Report (SAR), ammonia concentrations that exceeded applicable MDC surface water standards in five deep man-made drainage canals adjacent to the CCS were located in bottom samples where dissolved oxygen levels were less than 1.0 mg/L. Ammonia levels in the middle and upper portions of the water column were compliant with county ammonia standards with the exception of middle samples in the Turtle Point Canal where the dissolved oxygen levels were also less than 1.0 mg/L. There are no state numeric ammonia standards for Class III marine waters. Using Tritium and salinity mixing analyses, the SAR analysis demonstrated that for those bottom canal samples that exceeded the Miami-Dade limit for ammonia, the maximum contribution attributable to the CCS was 8% with an average of 2.85%. The SAR also established that the estimated CCS contribution to surface water site with ammonia levels below the county standard ranged from 0.4 to 16%. These evaluations were conservative as the potential for CCS ammonia contributions to the deep man-made canals were made using the concentrations of total nitrogen in the CCS (to address the theory that total nitrogen in CCS waters was being converted to ammonia in groundwater and then being transported to the adjacent canals) which were much higher that the ammonia concentrations in the CCS. Thus, if there is any contribution to ammonia concentrations in adjacent surface water from groundwater beneath the CCS, it is de minimis. FPL also outlined the numerous successful actions taken to reduce nutrient levels in the CCS and the additional actions underway that address nutrient contributions from the Turkey Point facility." (**0017-2-4** [Maher, William])

Response: *The discussion in the cited portion of the SEIS relates to groundwater quality, specifically ammonia and not surface water quality, which is discussed separately in Section 3.5.1.4 of the SEIS. Ammonia levels in the CCS and vicinity are correctly described in that section. Further, in Section 3.5.1.4 under "Ammonia and Nutrients within Biscayne Bay and Card Sound," the NRC staff observed that ammonia values are consistent with the anoxic conditions that exist at the bottom of remnant canals and the accumulation of organic matter falling into the remnant canals from surrounding areas of the bay. The comments provide no new information, and the SEIS text was not changed in response to these comments.*

Comment: Section 3.5.1.1, Page 3-34. The DSEIS states: "The canals generally discharge the most freshwater into the bay and sound during wet times of the year and the least during dry periods. As a result, salinity concentrations throughout the year in the bay and sound are more variable in time and space than prior to the construction of drainage canals (NRC 2016a)." This statement is incomplete. In addition to canal discharges to the bay, USGS studies have shown a reduction in groundwater stages as a result of drainage have affected Bay salinities as a result of reduced fresh groundwater seepage into near shore coastal waters (see "Evaluation of Effects of Changes in Canal Management and Precipitation Patterns on Salinity in Biscayne Bay, Florida", Using an Integrated Surface-Water/Groundwater Model", Scientific Investigations Report 2012-5099). This is a significant factor in the water quality in the Bay and Sound. This statement should be revised by adding: "In addition, canal management practices lower area groundwater table elevations which have reduced fresh groundwater seepage into Biscayne Bay and Card Sound further affecting coastal salinity." (**0017-2-11** [Maher, William])

Response: *Section 3.5.1.1 has been revised, in part, as a result of this comment, to indicate that groundwater table elevations may be affected by the presence of the drainage canals that intercept surface runoff and therefore prevent infiltration of that runoff to the groundwater table. However, the strong conclusion suggested by the comment is not found in the cited USGS Scientific Investigations Report 2012-5099.*

Comment: Section 3.5.1.1, Page 3-34. The DSEIS states: "The Turkey Point site occupies an area of former sheet flow that discharged into the bay. However, development of the site's location blocks sheet flow from reaching Biscayne Bay (NRC 2016a)." This statement is inaccurate because sheet flow into Biscayne Bay and Card Sound had been intercepted by the construction of the L-31E canal/levee in the early 1960's prior to the construction of the CCS. This statement should be revised to: "The Turkey Point site and L-31E canal/levee occupies an area of former sheet flow that discharged into the bay. Development of the L-31E canal/levee and the TP site has blocked historic sheet flow from reaching Biscayne Bay and Card Sound. However, FPL installed a series of 40 culverts through the L-31E levee in 2009 that re-established sheet flow into Card Sound." (**0017-2-12** [Maher, William])

Response: *Section 3.5.1.1 has been revised, in part, as a result of this comment, to describe the effects of the Central and Southern Florida Flood Control Project (L-31E canal/levee) on historical sheet flow near the Turkey Point site.*

Comment: Section 3.5.1.1, Page 3-35. The DSEIS states: "The Florida legislature has designated Biscayne Bay and Card Sound, including Biscayne National Park, as Outstanding Florida Waters. This affords these waters the highest water quality protections in the State (NRC 2016a; Robles, et al 2005; NPS 2012). The FDEP cannot issue permits for direct discharges to Outstanding Florida Waters that would lower ambient (existing) water quality and may not issue permits for indirect discharges that would significantly degrade a nearby waterbody designated as an Outstanding Florida Water (FDEP 2017a)." As a completeness clarification, the following language should be added to the above paragraph: "However, the CCS was authorized and constructed prior to the OFW designation was enacted and Florida water quality rules provide exceptions for existing facilities that were permitted prior to the effective date of the Outstanding Florida Water designation (chapter 62-4.242(2)(a) F.A.C.). The effective date of the OFW rule was 3/1/1979 and Card Sound, Biscayne Bay National Park were added to the rule in 12/1/1982 and 5/14/1986 respectively (chapter 62-302.700 F.A.C.). The first NPDES permit for Turkey Point including the CCS was effective on September 23, 1973." (**0017-2-13** [Maher, William])

Response: *Section 3.5.1.1 of the SEIS has been revised, in part, as a result of this comment, to clarify Florida water quality rules that apply to the CCS.*

Comment: Section 3.5.1.4, Page 3-46. The DSEIS states: "Most of the salt in the CCS comes from the groundwater of the Biscayne aquifer which is saltwater. As groundwater from the Biscayne aquifer moves into the CCS, the salt it contains also moves into the CCS. The Biscayne aquifer obtains its salt from Biscayne Bay, and is hydrologically connected to both the Biscayne Bay and the CCS (FPL 2018f, Tetra Tech 2014, FPL 2016a)." The statement is incomplete as it doesn't explain how the saltwater in the Biscayne aquifer becomes hypersaline in the CCS. The salt levels in the CCS are concentrated as a result of limited rainfall and evapotranspiration. This statement should be revised to: "As groundwater from the Biscayne aquifer moves into the CCS, the salt it contains also moves into the CCS and becomes concentrated as a result of evaporation. FPL's addition of fresher groundwater from the Floridan aquifer offsets the freshwater lost to evaporation is the underpinning of the strategy to lower CCS salinities to mirror the salinities in the Bay." Also, the second sentence regarding the hydrologic connection between Biscayne Bay and the CCS is more complex than this sentence conveys and a more detailed discussion of the hydraulic relationship between the CCS and the Bay is previously covered in Section 3.5.3, page 3-31 and 3-32 (refer to Comment Item 13). (**0017-2-14** [Maher, William])

Response: *Section 3.5.1.4 of the SEIS has been revised, in part, as a result of this comment, to indicate that salt in the CCS is concentrated as a result of evaporation.*

Comment: Section 3.5.1.4, Page 3-41. The DSEIS states: "In response to orders from the State of Florida and Miami-Dade County, FPL conducts an extensive water quality monitoring program that includes the CCS, Biscayne Bay, Card Sound, marshland, mangrove areas, and canals adjacent to the CCS. A major objective of this program is to evaluate the effects, if any, of CCS operation on the surrounding environment." This statement is inaccurate because the extensive monitoring conducted by FPL is in response to conditions X and XI of the State of Florida PPSA License PA 03-45E and the 5th Supplemental Agreement with the SFWMD not the Department of Environmental Protection Consent Order or the Miami-Dade County Consent Agreement. This statement should be revised to: *Pursuant to conditions of the State of Florida PPSA License PA 03-45E, FPL conducts an extensive ...." (**0017-2-15** [Maher, William])

Response: *Section 3.5.1.4 of the SEIS has been revised, in part, as a result of this comment, to indicate that pursuant to conditions of the State of Florida PPSA License PA 03-45E, and in accordance with the FPL Turkey Point Power Plant, Groundwater, Surface Water, and Ecological Monitoring Plan, FPL conducts an extensive water quality monitoring program that includes the CCS, Biscayne Bay, Card Sound, marshland, mangrove areas, and canals adjacent to the CCS.*

Comment: Section 3.5.1.4, Page 3-41. The DSEIS states: "This water quality monitoring program monitors surface water bodies for numerous water quality parameters, including ammonia and other nutrients and salinity." This statement is inaccurate because it under represents the depth of analytical data used to assess surface water quality. FPL analyzes surface water samples for 29 parameters, including physical parameters including salinity, anions, cations, tritium, ammonia and other nutrients. The statement should be revised to: "...surface water bodies for twenty nine water quality parameters including physical parameters such as salinity, temperature and specific conductance, anions, cations, tritium, ammonia and other nutrients." (**0017-2-16** [Maher, William])

Response: *The cited statement is accurate in that it mentions numerous water quality parameters monitored by FPL and focuses on the parameters that have been of particular interest to the public and State of Florida regulatory agencies. This comment provides no new information, and the SEIS text was not changed in response to this comment.*

Comment: 3.5.1.4, Page 3-42. The DSEIS states: "Between June 2010 and May 2016, ammonia concentrations within the CCS ranged from below detectable levels to 0.3 mg/L and averaged 0.04 mg/L (FPL 2017c)." Ammonia data values could not be verified in the cited reference. Suggest the sentence be replaced with the following sentence: "Average ammonia levels within the CCS canals are well below Chapter 24-42(4) surface water standards of 0.5 ppm." (Enclosure 2 to FPL letter L-2019-031 dated April 3, 2019 (ADAMS Accession Nos. ML 19095B380 and ML19095B384). (**0017-2-17** [Maher, William])

Response: *Section 3.5.1.4 of the SEIS has been revised, in part, as a result of this comment, to correct the reference cited in the DSEIS.*

Comment: Section 3.5.1.4, Page 3-46. The DSEIS states: "The salinities of seawater are around 34-35 practical salinity units (PSU), while the salinity of water in the CCS is presently around 60 PSU, or almost twice the salinity of seawater (EB 2018, FPL 2018f)." This statement is inaccurate because the 60 PSU value does not represent recent conditions. The average annual CCS salinity in 2017-2018 was 51 PSU. This statement should be revised to: "...while the salinity of water in the CCS in 2015-2017 was around 60 PSU, most recent annual average salinity for the CCS was 51 PSU (2017 - 2018)." (**0017-2-18** [Maher, William])

Response: *Section 3.5.1.4 of the SEIS has been revised, in part, as a result of this comment, to update the CCS salinity values to those reported most recently in the FPL Turkey Point Plant Remediation/Restoration Report, December 2018.*

Comment: Section 3.5.1.4, Page 3-48. The DSEIS states: "The County recommended that FPL revisit this alternative for further evaluation as a potential long-term solution (MDC 2016a). The current status of this proposal is unclear." This statement is outdated. This statement should be revised to: "At the time of this report, FPL and MDC were evaluating a potential cooperative reclaimed water use project for Turkey Point." (**0017-2-19** [Maher, William])

Response: *Section 3.5.1.4 of the SEIS has been revised, in part, as a result of this comment, to clarify the current status of plans to use reclaimed water from Miami-Dade County.*

Comment: Section 3.5.1.4, Page 3-51. The DSEIS states: "In response to the modified consent agreement between FPL and Miami Dade County, FPL submitted a corrective action plan to Miami-Dade County on September 14, 2016." This statement is inaccurate because the wrong plan is identified. This statement should be revised to: "...submitted a Site Assessment Plan to Miami-Dade County on September 14, 2016 (FPL, 2016g)." (**0017-3-1** [Maher, William])

Response: *Section 3.5.1.4 of the SEIS has been revised, in part, as a result of this comment, to report the submission of a Site Assessment Plan by FPL to Miami-Dade County.*

Comment: Section 3.5.1.4, Page 3-51. The DSEIS states: "As of July 5, 2018, FPL was in the process of obtaining the final permits for these restoration projects (FPL 2018f)." This statement is inaccurate because it does not reflect the current status of these projects. This statement should be revised to: "The Turtle Point Canal restoration was completed in April 2019 and restoration of the Barge Turning Basin began in May 2019 is scheduled to be completed by September 2019." (**0017-3-2** [Maher, William])

Comment: Section 3.5.1.4, Page 3-52. The DSEIS states: "Restoration activities at Turtle Point will backfill one-third of the remnant canal up to a depth of 0.33 ft (0.1 m) below MSL (for future Mangrove Planting)." This statement is inaccurate because it does not reflect the current status of these projects. This statement should be revised to: "Restoration activities at Turtle Point Canal included backfilling one-third of the remnant canal up to a depth of 0.33 ft. (0.1 m) below MSL and the planting of approximately 1,700 mangroves was completed in April 2019." (**0017-3-3** [Maher, William])

Response: *Section 3.5.1.4 of the SEIS has been revised, in part, as a result of these comments, to update the status of the Turtle Point Canal and Barge Turning Basin restoration projects.*

Comment: Section 3.5.1.4, Page 3-56. The DSEIS states: "The rate and direction of this water movement depend on the head differences between the CCS and the Biscayne aquifer (FPL 2018f, NRC 2016a)." This statement does not include additional factors that affect rate of water movement. Suggest the statement be expanded to: "...head differences between the CCS and the Biscayne aquifer, hydraulic conductivity of the canal sediments, and fluid density differences between fluids in the CCS and Biscayne aquifer (FPL 2018f, NRC 2016a)." (**0017-3-4** [Maher, William])

Response: *Section 3.5.1.4 of the SEIS has been revised, in part, as a result of this comment, to clarify factors affecting movement of water between the CCS and the Biscayne aquifer.*

Comment: Section 4.5.1.1, Page 4-23. The DSEIS states: "Hypersaline groundwater flow from the CCS beneath Biscayne Bay would, however, continue to move eastward and downgradient along the base of the Biscayne aquifer." This forecast statement is not supported by the actions and regulatory requirements in place today. With the CCS salinity reduced to 34 psu (equaling Biscayne Bay's salinity), and the RWS wells extracting hypersaline water, the source of hypersaline water to drive the continued easterly movement along the base of the aquifer will be gone long before the expiration of the current site license. This statement should be revised to: "Hypersaline groundwater flow from the CCS beneath Biscayne Bay would, however, diminish over time after the CCS salinities are reduced and maintained at levels equal to the Bay (34 PSU) and the hypersaline groundwater beneath and west of the CCS is removed by the RWS extraction wells." (**0017-4-7** [Maher, William])

Response: *While freshening of the CCS to 34 PSU may prevent additional hypersaline water infiltrating to the bottom of the Biscayne aquifer and the recovery well system may extract parts of the hypersaline plume beneath the CCS, the NRC staff believes the hypersaline plume will continue to move eastward and downgradient. This comment provides no new information, and the SEIS text was not changed in response to this comment.*

Comment: Section 4.13.7, Page 4-97. The DSEIS states, "During operation, some minor amounts of chemical wastes may result from efforts to maintain appropriate chemical quality of the recirculating cooling water, from the periodic maintenance (i.e., descaling) of the cooling towers, and from periodic removal of settled precipitates from the cooling water basins beneath each cooling tower." This statement is incomplete because it does not consider information from NUREG-2176, Vol. 1 Environmental Impact Statement for Combined Licenses (COLs) for Turkey Point Nuclear Plant Units 6 and 7, Section 3.4.2.3, which discuss the Injection Wells for cooling towers blowdown. Units 3 and 4 would need a method for disposal of liquid radioactive waste, in accordance with Part 20 methods, like Units 6&7 if the CCS is removed from service. Currently, Units 3 and 4 discharge liquid radioactive waste to the CCS, but it is diluted to meet Part 20 requirements. If the plant no longer discharges circulating water to the CCS, it would need to identify an alternative method for discharge of radioactive waste. This scenario was analyzed in detail in the Safety Evaluation and FEIS for the Units 6&7 COL project. This statement should be revised accordingly. (**0017-4-17** [Maher, William])

Response: *A discussion of disposal of liquid radioactive waste for the cooling water system alternative is included in Section 4.5.7.2. As stated in Section 4.5.7.2, operation of mechanical-draft cooling towers for condenser cooling would produce cooling tower blowdown that may contain water treatment and conditioning chemical residuals necessary for proper operation of the cooling towers. Additionally, Turkey Point Units 3 and 4 operations would continue to produce various process water effluents, including liquid radwaste effluents. The NRC staff assumed that these effluents would be disposed of by deep well injection into the Boulder Zone, which would be regulated under a Class I underground injection control permit issued by the FDEP (FAC 62-528). This comment provides no new information, and the SEIS text was not changed in response to this comment.*

Comment: I hope that people will find it incredibly alarming as far as I understand it, that this is the only nuclear facility in the world that has a cooling canal system. Is that right? Can anybody else? Is that wrong? That's incredibly alarming. So the fact that we are even considering issuing a permit to continue this, is absolutely ludicrous and I hope that you think long and hard on it. So this is a known fact, that commonly important species are diminished to disappear over time as salinity increases. We also know that nutrients are so high in the plume that it is also changing the near shore environment of Turkey Point which is in a National Park and a National

Marine Sanctuary.
(**0001-11-3** [Friedman, Steve])

Comment: So there was a situation where the water in the cooling canals has heated up during periods of intense heat, specifically in the summer. Algae is covering the canals and acting as a thermal blanket. Those canals cool the reactors. If they're not cooling the reactors then the reactors would have to be shut down. So this is why Laura Reynolds referred to the use of massive amounts of Floridan water to freshen or cool and desalinize these cooling canals. To date, because FPL speaks regularly at our association in Ocean Reef -- today, Mr. Sole admitted that he still doesn't have those canals down to the proper salinity, which is supposed to be the salinity of the Bay. And they're not there yet and they've been as high as three times saltier than sea water. And that's why everything died. Everything in the cooling canal system died. (**0001-14-3** [Rippingille, Bonnie])

Response: *Operations of the CCS are described in Section 3.1.3.2 of the SEIS and the interactions between the CCS and adjacent surface and ground waters are described in Section 3.5. Terrestrial and aquatic resources, including special status species and their habitats are described in Sections 3.6 through 3.8. The impacts from continued CCS operations on water resources, terrestrial resources, aquatic resources, and special status species and related habitats are described in Chapter 4 of the SEIS, Sections 4.5.1, 4.6.1, 4.7.1, and 4.8.1. These comments provide no new information, and the SEIS text was not changed in response to these comments.*

Comment: Anyway, so they're using this water that really was designed for the CERP, which is the Comprehensive Everglades Restoration Plan project, such as the Biscayne Bay Coastal Wetlands, which are very close to the plant. And they're using that water and that's in direct conflict with the CERP. FPL must be required to use readily available treated municipal waste water for the nuclear plant. Well, they had a plan for that and they entered into -- in 2018 FPL visited us and told us, well, we're working on this waste water facility that we're going to do with Miami-Dade County. Well, guess what, folks. They don't have an agreement yet as to how the water needs to be cleaned and to what level it needs to be cleaned. Miami-Dade is saying it has to be to non-degradation standards, and that is because the water is going into the Bay and outstanding Federal waters. That's why it has to be clean, almost to drinking water standards and that costs a lot of money and somebody else is going to address that after me. (**0001-14-5** [Rippingille, Bonnie])

Response: *The SEIS recognizes that FPL and Miami-Dade County are evaluating a potential cooperative reclaimed wastewater use project to provide freshening water to the CCS. The discussion of alternative water sources to reduce CCS salinities is described in Section 3.5.1.4 of this SEIS. This comment provides no new information, and the SEIS text was not changed in response to this comment.*

Comment: I've looked at lot of data, I've reviewed the EIS. I've looked at a lot of data that's submitted since the Scoping Meeting. And I would mention in looking at the EIS, I would encourage the committee -- there's a lot of data that was generated in late 2016, 2017 and 2018 that I don't find referenced in the EIS. I see a lot of references to 2014, '15 and '16. And there are a lot of organizations that really have been energized in the last three years and done a lot a data collecting, a lot of expert testimony brought to bear that I think clearly shows the environmental impact of this antiquated component of the nuclear power plant open canals. I think the data, actually in my opinion, clearly shows that FP&L has failed to, over the decades, to operate and maintain this shallow open cooling canal system properly, either due to gross negligence, in my opinion, or incompetence and in compliance, therefore it isn't. It's violated -- had violations to its NPDES permit that expired about five years ago. And it's been administratively continued. I would, I guess for those who say it wouldn't be gross negligence or incompetence, it's not the case with FP&L, then the only other plausible reason that I can come up with is that the CCS is a failed design that cannot be operated and maintained to meet its NPDES permits. It was originally designed to include the sea water to sea water exchange. It was never a closed loop or closed system. I think there is a preponderance of data that indicates that it, you know, twice a day, I mean you get a high and low tide. There is a sea water exchange between the canals and the Bay. And so it clearly, whatever is in the canals twice a day exits into the Bay and vice versa. So it clearly, you know, the water quality in canals is impacting the Bay I'm going let others and the evidence that's been put forth support that. (**0001-16-2** [Schoedinger, Steven])

Response: *Section 3.5 has been updated in part in response to this comment by incorporating 2018 groundwater and surface water data. Operations of the CCS are described in Section 3.1.3.2 of the SEIS and the interactions between the CCS and adjacent surface and ground waters are described in Section 3.5. In preparing the SEIS, the NRC staff used data available from FPL in its annual monitoring reports and remediation/restoration reports, including those from years 2016, 2017, and 2018. The SEIS also used data and information collected and reported by State of Florida regulatory agencies including FDEP, MDC, and SFWMD; Federal agencies including FWS, EPA, NMFS, NOAA, NPS, USACE, USCG, USGCRP, and USGS; and scientific studies published in open literature.*

Comment: On the other side, it's leaking into Biscayne Bay like it always did. And so now we're on plan number 6 and it's more pumping, it's another experimental scheme. You can know it's an experiment because the remedy if it fails is another plan. Plan number 7 is what's required if it fails. It's an acknowledgment that this system does not and cannot work. And so now we have the craziest solution in the world now, which is that now we're going to put treated sewage in it, adding treated sewage to aquifer to solve this problem. This is absolutely crazy. It had a design flaw from the very beginning. Nothing has ever been done to make it fixed, to fix it. You've got now a sewage scheme to make it even worse. (**0001-17-3** [Guest, David])

Response: *Operations of the CCS are described in Section 3.1.3.2 of the SEIS and the interactions between the CCS and adjacent surface and ground waters are described in Section 3.5. The impacts from continued CCS operations on water resources are described in Section 4.5.1. FPL evaluated the potential use of reclaimed wastewater for freshening of the CCS (Section 3.5.1.4 under "Study of Alternatives to Reduce CCS Salinities"). As reported in that section, FPL decided not to use reclaimed waste water but to use water from the Floridan aquifer. This comment provides no new information, and the SEIS text was not changed in response to this comment.*

Comment: Samples of bay water at various depths and sites around the power plant show elevated levels of salt, ammonia, phosphorous, and tritium. (**0016-1** [Cochrane, Theodore])

Comment: I have video showcasing the ultra green, high turbidity cooling canals. The video was taken after the FPL fresh water recharge events within the cooling canals. The poor condition of the water quality showcases that the water recharge methodology is not a permanent solution. Furthermore, the recharging simply pushes down the hyper saline plume via ionization transfer and pressure into our water supply further contaminating our ground water and advancing the radioactive hypersaline pollution plume. (**0020-8** [Gomez, Albert])

Response: *Section 3.5.1.4 of the SEIS describes the water quality in the CCS. Section 3.5.2.2 of the SEIS describes groundwater quality. Impacts to surface water and groundwater quality associated with continued operations of Turkey Point Units 3 and 4 under the proposed action are described in Sections 4.5.1.1 and 4.5.1.2 of the SEIS. This comment provides no new information, and the SEIS text was not changed in response to these comments.*

Comment: [With more time, the NRC and associated regulatory agencies can review new information on...] Negatively cascading water quality within the cooling canals ....Radioactive high salinity pollution plumes continuing to advance and seep from cooling canals into our water supply in violation of several federal, state and county regulations with no validated clean up methodology to recapture the increasing polluted water ...Ongoing and concurrent consent decrees between the EPA, FL DEP, DERM and Miami-Dade county within Miami-Dade County mandating the county improve water quality, which is below standard and behind the stated schedule for clean up and nutrient reduction. Turkey Point is negatively impacting water quality and nutrient load through the ongoing operation of Turkey Point Reactor 3 & 4 and associated polluting cooling canals, and in so will further delay adherence to the consent decree and associated guidelines (**0020-5** [Gomez, Albert])

Response: *Impacts to surface water and groundwater quality associated with continued operations of Turkey Point under the proposed action are described in Sections 4.5.1.1 and 4.5.1.2 of the SEIS. The NRC staff's review of new information is described, in part, in Section 4.14 of the SEIS. Various agreements and orders involving State and County regulatory agencies and FPL are described in Chapters 3 and 4. This comment provides no new information, and the SEIS text was not changed in response to this comment.*

Comment: Surface Water Resources. The DSEIS evaluated the significance of new information relating to impacts from the CCS on adjacent surface water bodies and provided that, "Water that likely originated from the CCS has sporadically been detected in two canals adjacent to the CCS", but concluded that the water quality in these two canals have not been degraded sufficiently to prevent these canals from achieving their intended purpose (i.e., transporting fresh water, draining the land and flood control) (page 4-23). However, the two canals being discussed were not specifically identified. The DSEIS should identity the canals that were evaluated. (**0022-2** [Hefty, Lee N.])

Response: *Section 4.5.1.1 of the SEIS has been revised, in part, as a result of this comment, to identify the two canals as the Card Sound remnant canal and the S-20 canal that are shown in Figure 3-4.*

Comment: DERM and WASD are requiring the cleaning of the reclaimed water to non degradation standards to avoid further impairment of the bay. This water quality standard and the 40 mgd a day that evaporates yearly from the canals make this an extremely costly process. FDEP has recognized southern Biscayne Bay is already impaired on their official list of impaired water bodies, which is why DERM is requiring the non-degradation standard. Because of the cost of cleaning the wastewater to nondegradation standards, there has been no agreement to date reached between FPL and WASD for the RO reclaimed water plant. We believe that approval of the proposed permit and the application for license renewal would be premature until the RO reclaimed water plant issues are resolved between Miami Dade County/DERM and FPL. (**0024-5** [List, Gary])

Comment: FPL is also seeking a new NPDES permit from the Florida Department of Environmental Protection which will allow FPL to continue discharging polluted hyper saline water from the (CCS)into the Biscayne Aquifer, our primary source of drinking water, and into the bay through the groundwater and porous limestone under the aquifer. FPL is not allowed to discharge into the navigable waters of the United States either directly or indirectly under its current FDEP pollution permit and FPL has been discharging for 35 years in violation of this permit. We understand that they will be required to have this permit as a condition of granting the SLRA and have asked that it be deferred or not issued until the extent of the damage caused by the operation of the CCS to the bay is assessed. (**0024-6** [List, Gary])

Comment: I implore the NRC to extend their date for final EIS a few months if necessary to consider the content of the final issued new NPDES permit, if one is issued, for FPL TPP. I don't know whether you realize, but that permit has not even been a live permit for practically ten years because of all the problems that FDEP recognized with FPL's compliance with the terms of their existing permit. So that's a very important issue. And the records, and I'm happy to supply them to your group, of their non-compliance and what was done about it in administrative hearings and other proceedings, resulted finally in DERM and FTP citing them for violations. And they're still in violation and they're going to continue in violation. And the NPDES permit conveniently appears to make those violations not a violation with respect to the Bay and the coverage under the NPDES permit. And I suggest to you that they know it's not going to work, and that's why they're going for this new permit. And this new permit was submitted during the final months of the Scott administration. And we didn't find out about it -- the environmental groups didn't find out about it until 15 days before the meeting, the public meeting on it. And there was an extension granted, and that meeting is going to take place next week, and we hope that everybody will come back so that we can talk about this again, because they are not in compliance with their permit. They know it, DERM knows it, FDEP knows it. And why would you give an NRC permit for another 20 years to FPL when they're in violation of their permit? And when they're in violation of the DERM and FDEP consent order and consent decree, why would you reward them like this? Because all you're going to do is incentivize them to continue to delay, delay, delay in doing something about those cooling canals. (0002-6-5 [Rippingille, Bonnie])

Response: *The commenters propose that the NRC delay its subsequent license renewal decision to await the FDEP's issuance of a renewed National Pollutant Discharge Elimination System (NPDES) permit for Turkey Point Units 3 and 4. The NRC's consideration of the Turkey Point subsequent license renewal application considers issues that are subject to NRC regulatory authority; environmental issues associated with issuance of a renewed NPDES permit are not within the NRC's regulatory authority to resolve. While the NRC coordinates with other regulatory authorities, the NRC cannot address issues that are not under its jurisdiction. The NRC does not have the authority to ensure compliance with other regulatory authorities' requirements under the Clean Water Act, and cannot make compliance with permits, agreements, and orders issued by other agencies a condition of the NRC license. Issuance of a renewed license, however, does not foreclose or restrict the ability of other regulatory authorities to take such actions as they deem necessary to ensure compliance with orders, consent agreements, or other regulatory requirements under their Clean Water Act or other lawful statutory jurisdiction.*

These comments provide no new information, and no changes have been made to this SEIS as a result.

Comment: The DSEIS does not evaluate potential cumulative impacts for surface water, based on the conclusion that "Since FPL is prohibited from discharging effluent into surface waters of the State, and the FDEP and DERM has imposed requirements for mitigation of the hypersaline plume originating from the CCS, subsequent license renewal is not expected to have a cumulative impact on surface water quality in combination with rising sea levels." The premise of this conclusion is flawed since the groundwater recovery well system is not designed for nor was it intended to address surface water impacts resulting from the CCS operations. (**0022-5** [Hefty, Lee N.])

***Response**: The Miami-Dade County DERM expresses concern that no cumulative impacts analysis is contained in the SEIS for surface water. As defined in Section 4.16 of the SEIS, cumulative impacts may result when the environmental effects associated with the proposed action (subsequent license renewal) are added to the environmental effects from other past, present, and reasonably foreseeable future actions. The NRC staff did not perform a cumulative impacts analysis specifically for surface water because the staff determined that the continued operation of Turkey Point Units 3 and 4 would have no incremental impacts on surface water. In this regard, Turkey Point Units 3 and 4 do not directly consume or discharge effluents to surface water bodies. The staff recognized, in Sections 3.5.1.4 and 4.5.1.1 of the SEIS, that CCS operations have resulted in minor impacts via the groundwater pathway to surface water quality in surface water bodies adjacent to the CCS. The staff determined, however, that impacts to surface water bodies via the groundwater pathway during the subsequent license renewal term would be SMALL, based on the staff's analysis presented in Section 4.5.1.1 (see "New Issue, Water Quality Impacts on Adjacent Water Bodies (Plants with Cooling Ponds in Salt Marshes").*

An evaluation of impacts over the period of subsequent license renewal from CCS flooding is discussed in response to the comment titled "Failure to Analyze Impacts of Sea Level Rise and Storm Surge" (Comment numbers 0023-14 and 0023-15). Except in the event of a hurricane, flooding and flood damage to the CCS is not likely to occur. The NRC staff's evaluation concludes that over the period of subsequent license renewal, overtopping of the CCS or a release of CCS waters into adjacent surface waters due to flooding could occur infrequently. However, if it does occur, it is likely to cause only SMALL changes to the water quality in Biscayne Bay and Card Sound.

Section 4.16 of the SEIS was revised to clarify the staff's basis for not preparing a cumulative impacts analysis for surface water resources.

Comment: And we were taken out, and I was present, and we did sample four separate what we call cave or upwelling exits, and we took about two dozen samples. And the photos show that the phosphorous was 1,000 percent greater than average geometric mean. And the nitrogen was 300 percent greater than average geometric mean. And the chlorophyl was 100 percent greater than average geometric mean. We were less than a quarter mile from the FPL plant and the cooling canals. And the well that we were close to was TPGW-14-D, less than one quarter mile east of the southeast corner of the CCS, the cooling canal system. (**0002-6-4** [Rippingille, Bonnie])

Comment: I have the charts that show what we found there out in that Bay, and I'm going to file them with you. I believe there's also video footage of the dive. I just collected the samples that came in and charted them on the chart. I wasn't diving. But we have video footage of it. So I implore you to look at their non-compliance over the last 30, 35 years and ask you to delay granting this license until they show that they can comply with the rules, the most important thing is your duty to comply with the rules. Because you're in an area where -- outstanding federal water, the Everglades, from which we get our water supply, on each side of this plant. (**0002-6-6** [Rippingille, Bonnie])

Response: *The data referred to in these comments, the methodology used to collect the data, and a description of any associated quality control were not provided to the NRC staff. Accordingly, the data referred to by the commenter are not considered in this SEIS. Rather, the NRC staff relied on data in FPL's submittals and data available at the Turkey Point Combined Monitoring Site (https://www.ptn-combined-monitoring.com/Home), which is the repository for monitoring data required to be collected and reported by cognizant regulatory authorities under various agreements and orders. Since the publication of the draft SEIS, the NRC staff also reviewed the monitoring data included in FPL's 2018 Annual Monitoring Report and in additional reports. The additional review did not result in alteration of the staff's conclusions in the SEIS. However, various sections of the SEIS, particularly Sections 3.5.1 and 3.5.2, have been updated as necessary to reflect the staff's review of the latest available monitoring data for surface water, groundwater, and ecology resources. This newly reviewed information is cited throughout the SEIS and is listed in Chapter 6 of the SEIS.*

Comment: Regardless, DERM finds that the DSEIS does not appear to have evaluated water quality impacts to the L-31E canal. Surface water data from that portion of the L-31E which runs parallel to and west of the CCS and the interceptor ditch indicate tritium concentrations (TPSWC-1,2,3 and TPL31E-INTS) that are inconsistent with and higher than tritium concentration in Biscayne Bay (TPBBSW-3, 4 and 5), and in the northern (TPL31E-INTN) reaches of the L-31E and station TPSWC-6 in the Card Sound Road Canal suggest surface water impacts that are persistent rather than sporadic as described by the NRC. (**0022-3** [Hefty, Lee N.])

Comment: Additionally, available data indicates that salinity levels in the L-31E (see attached) [view attached figure in pdf, available from NRC ADAMS, accession no. ML19147A229], which has historically been a fresh water canal, are increasing. Given the importance of this canal to the fresh water wetland resources in the Model Lands west of Turkey Point and the coastal wetlands to the south, degradation of the water quality in this canal will result in impaired functionality which becomes more critical with the sea level rise projections. DERM recommends the Draft DSEIS be amended to include further evaluation of the impacts to the L-31E canal. (**0022-4** [Hefty, Lee N.])

Response: *In these comments, the Miami-Dade County DERM expresses concern that the SEIS does not adequately characterize and assess water quality impacts to the L-31E canal (primarily tritium and salinity levels), which could then affect nearby wetlands and surface waters.*

In the vicinity of the Turkey Point site, the L-31E canal generally is located to the west of the CCS and runs northeast to southwest. West of the Turkey Point site, the L-31 canal is a dead-end canal and is generally filled with stagnant water. The northern end of the canal dead ends against SW 344th Street, while the southern end of the canal dead ends against Card Sound Road. A section of the L-31E canal, located west of approximately the (north-south) midpoint of the CCS, contains a partial plug of sediment that restricts any southward flow of *water from the northern-most section of the canal. The east side of the L-31E canal contains a levee. This levee is designed to provide flood protection to properties further west (see Section 3.5.1.1, "Surface Water Hydrology, Potential for Flooding at the Turkey Point Site").*

Historically, in the L-31E canal, the water quality ranges from fresh to brackish. Increases in specific conductance (an indirect measure of salinity) have historically been observed during the latter part of the dry season. Salinity concentrations near the surface of waters in the L-31E canal are consistently lower than concentrations from the bottom of the canal. This is expected as more saline water is denser than less saline water. Salinity concentrations in the canal drop in response to heavy rain events or when the water is released from the L-31E canal (FPL 2018o).

During wet periods, the levee on the east side of the canal prevents surface water in the low-lying areas west of the levee from moving eastward; at these time, excess water is discharged from the L-31E Canal into Card Sound via the S-20 Canal or into wetlands southeast of the weirs. As this discharge takes place during wet periods, salinities and nutrients should be greatly diluted in water discharged from the L-31 canal, by surface runoff flowing southward toward the weirs. Section 3.5.1.4 of the SEIS has been updated to summarize new water quality information obtained from FPL (2018o).

At Turkey Point, the highest tritium concentrations have been detected closest to the CCS and have been found to diminish with distance from the CCS. When compared to the L-31E canal, the tritium concentrations in the relatively large water bodies of Biscayne Bay and Card Sound are quite low. As explained in Section 3.5.1.4 of the SEIS, there are two possible pathways for tritium to leave the CCS and move to another surface water body: (1) through the groundwater pathway or (2) through air via steam or water vapor). The tritium concentrations in samples collected from the L-31E canal appear to be heavily influenced by the atmospheric pathway. For example, over the June 1, 2017 through May 31, 2018 monitoring period, tritium concentrations in evaporation pans (i.e., from precipitation) located near the L-31E canal and monitor well TPGW-31 were often more than 100 to 200 pCi/L. Tritium values in samples from L-31E canal water contained similar concentrations (FPL 2018o).

During the annual monitoring period from June 1, 2017 through May 31, 2018, water in the L-31E canal had significant increases in salinity. The salinity increases occurred during and after an extended dry period and were observed in most of the marsh sites in response to dry conditions during the drought and in response to the storm surge during Hurricane Irma. Increases in soil porewater salinities were also detected at all ecological transects, including one located approximately 4 mi (6.5 km) southwest of the CCS (FPL 2018o, NRC staff review of data available in FPL's Electronic Data Management System (EDMS; https://www.ptn-combined-monitoring.com)).

The increases in salinity levels are not believed to have been caused by a failure of the interceptor ditch. This is because (a) surface water levels have consistently indicated that groundwater flow was eastward from the L-31E canals towards the interceptor ditch and towards the CCS; (b) the L-31E canal water tritium values are within the ranges observed from atmospheric deposition; (c) L-31E canal water tritium values did not respond commensurately and consistently with changes in the canal water's salinity; and (d) tritium concentrations at all terrestrial soil porewater sites were within historical ranges (FPL 2018o). Rather, the increases in salinity in the marsh lands, soils, and the L-31E canal are believed to have been caused by the evaporation of water from the marsh lands, soils, and the stagnant water in the L-31E canal *during dry periods. This was followed in some areas by increased salinity caused by storm surges (FPL 2018o).*

The SEIS has been updated to summarize the new information obtained from FPL (2018o) and from the NRC staff's review of data available in FPL's Electronic Data Management System (EDMS; https://www.ptn-combined-monitoring.com).

Comment: Now the new scheme is even more exotic than the previous ones. Now what we're going to take is treated sewage water and put it into these aquifer canals. There is no honest debate about where there's a direct connect between these aquifer canals and Biscayne Bay. It's established in nine different ways. Nobody's seriously contested it. If you read your EIS, FPL minimizes it, certainly minimizes it, but doesn't deny it. No honest person could even think about denying that. And so what you're talking about doing is putting sewage water into the canals, which goes straight into Biscayne Bay. And what's happening in Florida? There's one big issue that's happening in the Florida environment, and that is the algae crisis. There is an algae crisis on East and West Coast. There's one in the great St. John's River, the biggest river in Florida, that's developing, as we speak. There's emergency measures by the Corps of Engineers, by Governor DeSantis, by the legislatures.

There's hundreds of millions of dollars of fixes to try to stop the algae crisis as it is now. But then you want to talk about adding sewage water into Biscayne Bay, which is teetering on the edge of collapsing like the rest of them have. It's crazy. It's absolutely crazy to be putting sewage water into a place where it's going to go straight into the Bay and risk a broadening toxic algae crisis. It just makes no sense at all. And you guys don't have -- as an alternative, you don't have the straight sea water exchange into Biscayne Bay, like it was long ago. And it's a good reason it's not there. It's because the carnage that it does to the Bay if you do that. Well, that's the standard that you should be operating on. Carnage to the Bay is not a viable alternative. And the sewage plant is just that, it's not a viable alternative, it should be taken off the table. (**0002-4-2** [Guest, David])

Comment: So not only do you have the salt loading that David Guest talked about, which is in direct conflict with the goals of Biscayne Bay coastal wetlands. The goal stated in the Yellow Book for that project is to bring the near shore environment back to mesohaline conditions. Which essentially means, bring it back to an estuary because it's been getting too salty. And the operations of the plant. Basically all it does is evaporate fresh water and leave behind salt and any contaminants that are in that water. And it does that very well, just like a radiator. And we know that whatever water is being pulled in through the water budget, that gets concentrated over time. That could be a little bit of fertilizer from a farm, it could be the salt from Biscayne Bay, it could be something from rainfall. And it could also be whatever input you have. So I think it's a good point that Steve Schoedinger made, that if you put in recycled sewage water, you're adding to the problem. Not only EPOCs, but also additional nutrients. (**0002-5-3** [Reynolds, Laura])

Response: *Sections 3.5.1.4 and 4.5.1 of the SEIS consider the impacts of CCS operation, including the deposition of phosphorus, other nutrients, and salinity on wetlands and surface waters. The NRC staff notes, however, as explained in the SEIS and defined in Section 2.1, that the NRC's proposed action (subsequent license renewal) includes the continued operation of Turkey Point Units 3 and 4 for an additional 20 years. This involves operating Turkey Point Units 3 and 4 and supporting facilities in their current configuration, including the continued use of the cooling canal system (CCS). As described in Section 3.5.1.4 of the SEIS (see "Salinity Management Plan") the use of reclaimed sanitary wastewater in the CCS is not part of the* *proposed action. As reported in Section 3.5.1.4 (under "Study of Alternatives to Reduce CCS Salinities"), FPL did evaluate the potential use of reclaimed wastewater for freshening of the CCS. However, FPL decided not to use reclaimed waste water, but to use water from the Floridan aquifer.*

Under the proposed action, the staff assumes that water for CCS freshening would continue to be withdrawn from the Upper Floridan aquifer. However, in the SEIS, the NRC staff evaluates two alternatives that would use reclaimed sanitary wastewater. These alternatives are the New Nuclear Alternative and the Cooling Water System Alternative as described in Sections 2.2.2.1 and 2.2.3 of this SEIS and evaluated in Chapter 4 of the SEIS. In both of these alternatives, reclaimed wastewater would be used as makeup water for cooling towers. The blowdown (discharge) from the cooling towers would be disposed of by deep well injection more than 3,000-ft (914-m) deep into the Boulder Zone beneath the Turkey Point site. The comments provide no new information, and no changes were made to the SEIS in response to these comments.

Comment: As the salinity of the canals has increased so has the temperature of the water in them. According to an article in the Miami Herald from 2016 overheating in the canals has caused FP&L to shut down reactors at least twice in the past few years. (**0032-5** [Bloom, Mary])

Response: *Overheating in the canals has not caused FP&L to shut down the Turkey Point Units 3 and 4 reactors. However as described in Section 3.5.1.4 (under "Temperatures within the Cooling Canal System"), prior to August 2014, the NRC had set the ultimate heat sink limit at 100 °F (37.8 °C). In early July 2014, the water temperature in the cooling canals began to approach the limit of 100 °F (37.8 °C); FPL then requested an increase in the temperature limit. In response, the NRC staff performed a safety and environmental analysis, and then established the current heat sink temperature limit of 104 °F (40 °C) (NRC 2014b). This comment provides no new information and no changes were made to the SEIS as a result.*

Comment: Nuclear power can be good in not polluting the air, but harmful to the natural world through pollution due to wastewater. It is important to stop this from happening. (**0048-1** [Meyer, Roger])

Comment: I grew up sailing on Biscayne Bay and even in the 60's you could walk across the bay at low tide if you knew where to go. My sister-in-law's father worked for FP & L and was concerned then about the water temperature increase. This is not anew problem but one that has new urgency with the rising sea levels. Have we learned nothing in 50 years? (**0050-1** [Chesnut, Joanna])

Comment: This area MUST be secured and the water treated and made safe. This can and DOES affect the Wildlife.....People and those in the surrounding areas. (**0106-1** [Dickinson, Vicki])

Comment: We cannot continue to destroy our environment especially our waters and expect to survive! (**0129-1** [Hostler, Joyce])

Response: *The commenters appear to express general concerns about water quality including nuclear reactor effluents and operation of the Turkey Point CCS. The facility's effluents are controlled by NRC requirements (see Section 3.1.4.1, "Radioactive Liquid Waste Management"), the technical specifications, and the facility's NPDES permit. Operations of the CCS are subject to a State-issued NPDES permit (currently in the renewal process) that* *contains specific requirements for impoundment design, construction, operation, maintenance, and reporting. As stated in the Notice of Draft Permit, the FDEP, based on FPL's application and supplemental information, has determined that FPL has provided reasonable assurance that the wastewater treatment and effluent disposal facility (the CCS) complies with the applicable provisions of Florida Statutes and Florida Administrative Code and that the proposed project (the continued CCS operations) would not adversely impact water quality as long as all of the conditions in the permit are complied with.*

These comments provide no new information and no changes were made to the SEIS as a result.

Comment:

However, these measures do little to mitigate the discharge of water into Biscayne Bay. Monitoring results indicate that adding water to lower salinity has had the effect of increasing discharge toward Biscayne Bay. Discharge to the bay occurs intermittently in response to changes in plant operations, heavy rainfall, and fluctuations in bay water levels, the last two being also affected by climate change and accelerated sea level rise.

[View pdf to see attachment w/color figures entitled "Future Impacts on Biscayne Bay of Extended Operation of Turkey Point Cooling Canals" by Laura Reynolds, James Fourqurean, and William Nuttle, available from NRC ADAMS, Accession No. ML19151A729]

(**0071-2** [Reynolds, Laura])

Response: *The operation of CCS and its connection to and effect on surface and groundwater resources are described in Sections 3.1.3, "Cooling and Auxiliary Water Systems," 3.5.1, "Surface Water," and 3.5.2, "Groundwater Resources." A discussion has been added to Section 3.7.4 of this SEIS regarding seagrass leaf nutrient monitoring in Biscayne Bay and Card Sound. This monitoring is conducted by FPL contractors to evaluate the effects, if any, of CCS operation on the surrounding environment.*

Comment: Executive Summary: In Table ES-I (page xviii), the NRC summarizes site-specific environmental impact characterizations related to the Turkey Point license renewal. The "Groundwater Resources" and "Aquatic Resources" categories include reference to volume withdrawal, radionuclide releases, organism entrainment, and thermal impacts, but omits "Water Resources" category, which addresses the hypersalinity plume and nutrient impacts that result from the CCS discharges. As previously discussed, the EPA is concerned that these impacts are not adequately discussed and would be better categorized as 'Moderate to Large' impacts for water resources. The EPA is also concerned that the omission of the most important environmental impact of the license renewal (especially in the Executive Summary) is problematic and does not adequately describe environmental impacts to readers seeking an overview of the SD EIS.

Recommendation: The EPA recommends the NRC provide an entry in Table ES-I in the FSEIS and briefly describes the water resource impacts from the CCS. (**0031-16** [Militscher, Christopher])

Response: *The category, "Water Resources," has not been omitted from Table ES-1 in the Executive Summary of the SEIS. Rather, the NRC separates water resources-related NEPA issues into the categories of "surface water" or "groundwater." The NRC's Category 1 (generic)* *issues for the analysis of environmental impacts associated with license renewal of nuclear power plants reflect the generic impacts codified in the NRC's regulations in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B. Table ES-1 in this SEIS only summarizes the NRC staff's impacts determinations for applicable Category 2 (site-specific) issues for the proposed action (subsequent license renewal) for Turkey Point Units 3 and 4, in accordance with 10 CFR 51.53(c)(3), 51.71, and 51.95(c). Table ES-1 is similar to, but not as detailed as, Table 4-2 in Section 4.1 of the "Environmental Consequences and Mitigating Actions" chapter of the SEIS. Impact levels (SMALL, MODERATE, and LARGE) for each resource area are established in accordance with the definitions in Section 1.4 of the SEIS, consistent with the NRC's definition of those levels in the GEIS for license renewal.*

Separately, in Table 4-1 of Section 4.1, the NRC lists the Category 1 (generic) NEPA issues that the NRC staff found to be applicable to Turkey Point. However, Category 1 issues are not included in the Executive Summary, and there are no Category 2 surface water resources issues applicable to Turkey Point Units 3 and 4. Regardless, the tables are intended to reflect the staff's final impact determination for each resource-specific issue, rather than to provide a synopsis of the myriad aspects of each resource that the staff considered as part of its impacts analysis. The NRC staff's detailed impacts analyses for the listed Category 2 issues are presented in Sections 4.2 through 4.16 of the SEIS, as applicable. Similarly, a synopsis of the NRC staff's generic analyses for Category 1 issues, and a description of the consideration of new and potentially significant information related to those issues, are also presented in Chapter 4.

This comment provides no new information, and no changes have been made to this SEIS as a result.

Comment: National Pollution Discharge Elimination System (NPDES): On page 3-1 (line 41) of the SDEIS states, "This network of canals forms a closed, recirculating source of water ... "This discussion should clarify that cooling canal system is a closed-cycle cooling system -but not a closed hydrologic system. This is because the current NPDES permit allows for seepages from the canals to groundwater. Surface water sampling data from Biscayne Bay detected the presence of tritium, which indicates that the canals may be hydraulically connected to surface waters. Additionally, data indicate there is a westward migration of the hypersaline groundwater plume from the canal. The SD EIS does not address the structural integrity of the CCS to retain releases of nutrient-rich wastewater in the canal to waters of the United States nor does it discuss the impact of these releases on surface water quality and aquatic life in Biscayne Bay. Recommendations: The EPA recommends that a water balance calculation for the site that shows all the potential sources of water supplying the site, and discharges and other releases from the site under normal operating conditions be included in the FSEIS. This balance should include seepages from the canal system and changes in evaporative losses. The EPA also recommends the NRC address the structural integrity of the CCS to retain nutrient-rich wastewater and associated impacts to surface water quality and aquatic life in Biscayne Bay. (**0031-11** [Militscher, Christopher])

Response: *A 1971 consent decree by the Federal District Court for the Southern District of Florida required FPL to discharge all cooling water from Turkey Point facilities into a closed-cycle cooling canal system, as referenced in Section 3.1.3.2 of the SEIS. Section 3.1.3.2 also notes that the CCS does not have a direct surface water connection to any outside surface water body. Further, Sections 3.1.3.2, 3.5.1.3, and 3.5.1.4 state that water is exchanged between the CCS and the Biscayne aquifer. Section 3.5.1.3 of this SEIS, which has been revised in this final SEIS, contains a description of the current and the draft NPDES permit* *issued by the State of Florida, including a description of the permit's requirements related to CCS impoundment design, construction, operation, and maintenance. A discussion of FPL's aging management program for the CCS has also been added to Section 3.5.1.3 of this final SEIS.*

Section 3.1.3.2, "Cooling Canal System Operation," describes the components of the water budget. In light of this comment, Section 3.1.3.2 has been updated to include a typical water budget schematic for the CCS, which shows components of the CCS water budget based on modeling predictions during the June 2015 through May 2017 period.

Comment: 3.5.1.4, (pg 3-48). States: "The study considered technical, environmental, economic, and social criteria. Relative to the ranking criteria, it ranked Alternative Five as the best overall and the most balanced alternative. It also identified that Alternatives One and Seven should be maintained as short-term backup water options to be used when appropriate and as needed during extreme conditions. It further determined that Alternatives Two, Four, Six, and Eight did not provide a significant advantage and should not be evaluated further unless conditions change."

Stating that direct treatment of CCS water to remove salinity (Option 6) "did not provide significant advantage and should not be evaluated further" seems to negate the environmental impact of contamination migration in the groundwater without providing supportive data or information. The underlining problem is salt concentration in the CCS. The language above states that economics was considered in these characterizations. However, the SDEIS does not define what is considered too expensive or detail any significant advantage. Also, if cost is the major factor in characterizing an option, then this should be stated with supporting estimates and data. (**0031-14** [Militscher, Christopher])

Response: *The commenter is concerned that Section 3.5.1.4 of the SEIS does not define or discuss the factors considered in determining viable alternatives to offset CCS water deficits. The discussion quoted and provided in Section 3.5.1.4 summarizes FPL's evaluation of alternative sources of water conducted to reduce CCS salinities in response to the 2017 Consent Agreement between Miami-Dade County and FPL.*

The purpose of this discussion in the SEIS is to provide a summary of an alternative study that was developed by FPL and reviewed by Miami-Dade County. The study was reviewed by Miami-Dade County approximately 2 years prior to the NRC's receipt of the Turkey Point subsequent license renewal application. The NRC did not have a role in evaluating or approving that study, nor does the NRC have the regulatory authority to approve it. As discussed in the SEIS, Miami-Dade County reviewed the evaluation and made a recommendation as to which alternative could provide a long-term, sustainable source of water to offset CCS water deficits. The process and factors that were considered by Miami-Dade County in providing a recommendation on the alternative to offset CCS water deficits are reflected in its report (MDC 2016a). The comments provide no new information, and no change to the SEIS was made in response to this comment.

Comment: 3.1.3.2, (pg 3-11, 12). States: "Sediments can build up in the channels of the CCS. These sediments can obstruct the lateral flow of water through the CCS and can also lower the rate of water movement into the CCS from the Biscayne aquifer. Therefore, CCS maintenance activities include the removal of accumulated sediments as required to maintain adequate water flow in the CCS (FPL 2018j).e"

Accumulated sediments do obstruct the rate of lateral flow across the CCS boundary but would also obstruct vertical flow if not removed. In actuality, CCS isolation is being sacrificed for the sake of maintaining volumetric capacity. Removal of low permeability sediments to maintain depth in the canals can be a 'net negative' from an environmental perspective. (**0031-13** [Militscher, Christopher])

Response: *As stated in Section 3.1.3.2, "Cooling Canal System Operation," of the SEIS, sediment build-up in the CCS canals can obstruct the lateral flow of water through the CCS and can also lower the rate of water movement into the CCS from the Biscayne aquifer. As described in Section 3.5.1.4, "Temperatures within the Cooling Canal System" and "Thermal Efficiency Plan for the Cooling Canal System," maintaining adequate water flow through the CCS is essential for safe and efficient operation of the CCS. FPL is required to monitor surface water, groundwater, and porewater quality in and around the CCS and to report them to State regulatory agencies so that they can take timely actions under their respective jurisdictions. This comment provides no new information and no changes were made to the SEIS as a result.*

Comment: Surface Water Resources - The information presented is incomplete and inaccurate. The CCS connection to surface water including the surrounding wetlands and Biscayne Bay is not recognized in the document. The document incorrectly states in multiple locations that there is no connection of the CCS to surface waters, which has been described in the previous comment. The description of the CCS and its operation is also incomplete and inaccurate. In Section 3 .1.3 .2 of the SEIS, the water budget and CCS operations are not described, which is relevant to both the consumption of surrounding surface waters and the impact of water quality of the surrounding surface waters. Several connections to Biscayne Bay have been documented, including in a State consent order. (**0005-2** [Vogel, Robert])

Comment: Cooling and Auxiliary Water Systems -An accurate and thorough water budget is necessary to identify all sources and losses of water to understand the full impact of the operations of the CCS. Section 3 .1.3 .2 of the SEIS describes the operation of the CCS as "closed," which is inaccurate as described previously. The salt within the system comes from the ocean and is a clear indication of water flowing into the CCS from Biscayne Bay while the salt plume beneath the system in the Biscayne Aquifer is an indicator of the free flow of water out of the system into the surrounding environment. Using the term "closed" when these two connections are clearly known is a mischaracterization of the system misrepresentation of the conclusions of the SEIS. The presence of a water budget within the Final SEIS would greatly clarify this situation and provide a sound basis for determining impacts. A brief history of the operations of the CCS and some of the difficulties that have been observed should be included in the SEIS. For example, in the application for the first license extension, which included power uprate of Units 3 and 4, FPL incorrectly predicted that there would be no impact on the operation of the CCS. This prediction was incorrect and while there is some argument over the specific cause, the immediate result was higher than expected temperature and salinity in the CCS. A variance on temperature was necessary to remain in operation and, to this day, we understand that the CCS remains reliant on additions of water in order to reduce salinity, control temperature, and continue to operate. (**0005-7** [Vogel, Robert])

Response: *The SEIS describes the hydrologic connection between Biscayne Bay and Card Sound in Section 3.5, "Water Resources." In this section, it is pointed out that "the CCS is hydraulically connected to surface waters including Biscayne Bay via the groundwater* *pathway." These factors have been considered as part of the NRC staff's characterization of surface water and groundwater resources as presented in Sections 3.5.1 and 3.5.2, as well as in the staff's impact analyses for water resources presented in Section 4.5, "Water Resources."*

Section 3.5.1.4 ("Adjacent Surface Water Quality and Cooling Canal System Operation") describes recent studies to evaluate potential effects of CCS operations via the movement of groundwater from the CCS to adjacent surface water bodies. In Section 3.5.1.2 ("Surface Water Consumption") it is pointed out that "surface water resources are not consumed by Turkey Point operations. All water consumed by Turkey Point is derived from groundwater resources." The SEIS points out that the groundwater underlying and surrounding the CCS is salt water. The section titled "Salinity within the Cooling Canal System" states that "most of the salt in the CCS comes from the groundwater of the Biscayne aquifer which is saltwater. As groundwater from the Biscayne aquifer moves into the CCS, the salt it contains also moves into the CCS... [T]he Biscayne aquifer obtains its salt from Biscayne Bay, and is hydraulically connected to both the Biscayne Bay and the CCS."

The history of the CCS during the period of the power uprates of Turkey Point Units 3 and 4 is described in Section 3.5.1.4 under "Temperatures within the Cooling Canal System." As pointed out in this section, "Historically, Turkey Points Units 1, 2, 3, and 4 all contributed heat to the CCS. Units 1 and 2 are now retired and no longer contribute heat to the CCS. Even under current operations (i.e., after the NRC approved extended power uprates for Units 3 and 4 on June 15, 2012 …the heat that Units 3 and 4 discharge to the CCS is less than the amount of heat Turkey Point had discharged to the CCS when Units 1, 2, 3, and 4 were all in operation."

Because of changing climatic conditions, the water budget for the Turkey Point site is always in a state of flux. A figure has been added to Section 3.1.3.2 to characterize a typical water budget for the Turkey Point site.

Comment: NRC staff explain the close connection between ground and surface water:

At the Turkey Point site, surface water (including the area's freshwater canals, wetlands, and the adjoining Biscayne Bay) and groundwater are closely connected. This close relationship is attributable to the very high permeability of the underlying Biscayne aquifer, which permits water to move relatively freely between the surface and subsurface and vice versa. As a result, the CCS is hydraulically connected to surface waters including Biscayne Bay via the groundwater pathway.17

Despite the NRC's identification of the close connection between groundwater and surface water and the hydraulic connection of the CCS to surface waters via a groundwater pathway, NRC staff also assert that the CCS "does not connect to any other surface water bodies."18 The characterization made by NRC of the CCS as a closed loop system that does not connect to surrounding surface bodies is inaccurate and directly contradicted by information contained within the same document.
17 Ibid.[United States Nuclear Regulatory Commission, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 5, Second Renewal Regarding Subsequent License Renewal for Turkey Point Nuclear Generating Unit Nos. 3 and 4, Draft Report for Comment, NUREG-1437 Supplement 5 Second Renewal, March 2019, pg. 3-4, emphasis added.], 3-31, 3-32
18 Ibid., 3-38
(**0023-7** [McLaughlin, Caroline])

Response: *As referenced in Section 3.1.3.2 of this SEIS, a 1971 consent decree by the Federal District Court for the Southern District of Florida required FPL to discharge all cooling water from Turkey Point facilities into a closed-cycle cooling canal system. Section 3.1.3.2 states that the CCS does not have a direct surface water connection to any outside surface water body. Further, Sections 3.1.3.2, 3.5.1.3, and 3.5.1.4 state that water is exchanged between the CCS and the Biscayne aquifer. Section 3.1.3.1 was updated, in part, as a result of this comment to state that the CCS does not directly connect to any other surface water bodies.*

Comment: The water quality impact to Biscayne Bay surface waters is not adequately addressed because the state of the nutrient condition in the Turkey Point area of Biscayne Bay is not presented. The numeric nutrient criteria for Biscayne Bay is not referenced or discussed in relation to the operation of the CCS, and the water use required by the CCS in daily operations from sources of the surrounding wetlands and Biscayne Bay is not adequately described. The NPS recommends providing additional detail and analysis regarding the status and condition of surface water and recommends changing the impact rating for surface water from "Small" to "Moderate-Large." (**0005-3** [Vogel, Robert])

Comment: Water Quality Impacts Biscayne Bay-The numeric nutrient criteria, established by the Florida Department of Environmental Protection, does not appear to be taken into account when scoring the impacts to surface water resources in Biscayne Bay in the EIS. Review of these nutrient criteria over the past few years shows that Total Nitrogen (TN) and Chlorophyll-a (Chia) have exceeded these criteria. Calendar year 2017 is a prime example of these conditions. Monitoring for the Turkey Point Cooling Canal System (CCS), shows that TN concentrations in the surrounding canals were greater than the TN numeric criterion (0.33 mg L-1) by as much as three times (Figures 4 and 5) [view figures in pdf available in NRC ADAMS at ML19143A166]. Similarly, sample locations established as transects from the east side of the CCS within Card Sound, all show TN concentrations that exceed the criterion with the highest values found in the locations closest to the CCS (Figure 4). Transects established from the east boundary of the CCS into Card Sound also show that Chi-a concentrations exceed the criterion (Figures 6 and 7). Given these elevated bay conditions appear to be linked via groundwater transport (see comments in the groundwater section) to the CCS, the rating established in Table 2-2 appears to underestimate the existing impacts of the CCS on Card Sound and the score, based on existing data, should be elevated to "Large." (**0005-8** [Vogel, Robert])

Comment: Moreover, monitoring data indicate that water from the CCS is also hydrologically connected to the waters of Biscayne Bay, with CCS water moving through or under berms.8 Pollutants from the CCS, including elevated levels of ammonia, phosphorus, TKN, total nitrogen, and chlorophyll a, have been detected in the waters of Biscayne Bay.9 The addition of excess nutrients, such as ammonia and phosphorus, into the nutrient-limited waters of Biscayne Bay and Biscayne National Park has the potential to stimulate algal growth,10 which could ultimately lead to seagrass die-offs, toxic algal blooms, and severe ecosystem disruption, thus presenting a serious ecological concern.
8 Cox, William L., U.S. Department of Interior National Park Service, Letter to James D. Giattina, U.S. Environmental
Protection Agency; Jonathan P. Steverson, Florida Department of Environmental Protection; and Jack Osterholt, Miami-Dade County, May 13, 2016.
9 Miami-Dade County Report on Biscayne Bay Water Quality Observations associated with the Turkey Point Cooling
Canal System operations, March 7, 2016 Memorandum from Mayor Carlos A. Gimenez to

Miami-Dade County Board of County Commissioners Chair Jean Monestime and members.
10 Cox, William, US DOI NPS letter to EPA, DEP, MDC, May 13, 2016. (**0023-5** [McLaughlin, Caroline])

Comment: Repeated Violations of Water Quality Standards

The connectivity between the CCS and surrounding waterways combined with persistent water quality issues involving hypersalinity and nutrification has resulted in the repeated violation of water quality standards by FPL over the years. Prior to 2010, seagrasses in the CCS served to remove nutrients that were added to the system. However, instances of high salinity and temperature in the canals led to a massive seagrass die-off and subsequent algal blooms in the CCS, significantly degrading water quality.19 Today, waters in the CCS are known to contain nutrient pollutants, including phosphorus, nitrogen, ammonia, and chlorophyll-a, which have subsequently been discharged into surrounding waterways. Indeed, ammonia exceedances have been repeatedly recorded in nearby waterways and attributed to contributions from the CCS. On April 25, 2016, the Florida Department of Environmental Protection (FDEP) issued a warning letter to FPL notifying them that monitoring data indicated that levels of ammonia exceeded ammonia water quality standards.20 On July 10, 2018, Miami-Dade County Division of Environmental Resource Management (DERM) issued a letter indicating that total ammonia concentrations in the Barge Basin, Turtle Point, Card Sound remnant canal, S-20 canal, and the Sea-Dade remnant canal were in exceedance of County surface water quality standards.21 Through an analysis of temperature and tritium data, the County concluded that the CCS is a contributing source of ammonia to the areas.22
19 Ibid.[United States Nuclear Regulatory Commission, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 5, Second Renewal Regarding Subsequent License Renewal for Turkey Point Nuclear Generating Unit Nos. 3 and 4, Draft Report for Comment, NUREG-1437 Supplement 5 Second Renewal, March 2019, pg. 3-4, emphasis added.], p. 3-44.
20 Ibid., p. 3-50.
21 Ibid., p. 3-52, 3-53.
22 Ibid., p. 3-52, 3-53. (**0023-8** [McLaughlin, Caroline])

Comment: 3.5.1.4, (pg 3-51). States: "The study and its conclusions are contained in an assessment published on March 17, 2017(FPL 2017c). The report concluded that the elevated ammonia values are attributable to the degradation of plant and animal material under anoxic (low oxygen) conditions in areas with lillle or no mixing with other surface waters. The occurrence of ammonia appears to be limited to the locations of deep stagnant anoxic water bodies. "
of Ammonia may result from degradation of organics in an anoxic environment, but the occurrence an anoxic environment in Bay waters (typically oxygenated) may be indicative of a nutrient source. Samples only collected from surface water (as opposed to sampling from bottom sediments or groundwater) could yield different results.

Recommendations: The EPA recommends the NRC critically evaluate statements taken from references describe the complexity and reflect that evaluation within the FSEIS. The EPA recommends that the FSEIS of pertinent systems in enough detail to provide readers of this document
with understandings without referencing separate documents. Additionally, the EPA recommends the NRC provide comprehensive system component range, property, and interaction descriptions in a concise, localized manner in the FSEIS. (**0031-15** [Militscher, Christopher])

Response: *The SEIS has been updated with respect to data on salinity and nutrients, including ammonia, phosphorus, nitrogen and chlorophyll-a, in the CCS and nearby surface waters. The local and regional hydrology including Biscayne Bay and Card Sound is described in Section 3.5.1.1, "Surface Water Hydrology." In addition to the descriptions within the SEIS, several detailed descriptions were incorporated into the SEIS by reference from the final environmental impact statement (FEIS) for the Turkey Point Units 6 and 7 combined licenses (NRC 2016a). For example, the following information from the FEIS for Units 6 and 7 was incorporated by reference:*

1. *A description of the South Florida Hydrologic System and how it has changed over time from FEIS Section 2.3.1.1 on pages 2-25 to 2-30, including Figures 2-8, 2-9, 2-10, and 2-11.*

2. *The regional surface water system west of Biscayne Bay and how it has changed over time from FEIS Section 2.3.1.1 on Pages 2-31 and 2-32, including Figure 2-12.*

3. *A description of the hydrology and hydrodynamics of Biscayne Bay from FEIS Section 2.3.1.1 on pages 2-33 through 2-38, including Figures 2-14, and 2-15, and Table 2-8.*

The SEIS points out that the Florida legislature has designated Biscayne Bay and Card Sound, including Biscayne National Park, as Outstanding Florida Waters. This affords these waters the highest water quality protection. The SEIS also points out that "…pollution from human activities also impacts the water quality of Biscayne Bay. Sections of the shoreline of Biscayne Bay are highly developed. The southern end of Biscayne Bay and Card Sound is less urbanized than the northern section of Biscayne Bay. Pollutants can potentially enter Biscayne Bay from multiple sources, including boats, canals, quarrying operations, landfills, military operations, a sewage-treatment plant, urban and agricultural runoff, and submarine groundwater springs (USGS 2008b)."

Section 3.5.1.4 ("Adjacent Surface Water Quality and Cooling Canal System Operation") of this SEIS describes recent studies to evaluate potential effects of CCS operations via the movement of groundwater from the CCS to adjacent surface water bodies. This section also includes a description of monitoring data and mitigative actions for ammonia and nutrients within Biscayne Bay and Card Sound. The text points out that "If the concentration of nutrients in either Biscayne Bay or Card Sound get too high, they can negatively impact the ecological environment. Excess nutrients can cause algae blooms (thick green algae mats that can be toxic), deplete oxygen in the water, and reduce water clarity."

The State of Florida (with the approval of the EPA) has established numeric nutrient criteria for Biscayne Bay and Card Sound. Section 3.5.1.4 ("Ammonia and Nutrients within Biscayne Bay and Card Sound") of the SEIS also states, "The numeric nutrient criteria include criteria for phosphorus, chlorophyll, and total nitrogen, of which ammonia is a contributor." Furthermore, the SEIS states, "Biscayne Bay waters are generally low in plant nutrients. This means the aquatic ecosystems respond very rapidly to small nutrient enrichment, especially to increases of phosphorous. The concentrations of ammonia from runoff tends to be higher in urban runoff than in wetland or agricultural runoff. The Biscayne Bay watershed has a diverse agricultural, urban, and wetland land use. This results in lateral differences in bay water nutrient concentrations." The text also points out that "in general, ammonia concentrations are higher in *the northern portion of Biscayne Bay, which is most urbanized, while the lowest values are next to the Turkey Point site in Biscayne Bay and in Card Sound."*

Commenting on the draft SEIS, the National Park Service produced isopleth maps of total nitrogen and chlorophyll-a concentrations for surface water bodies including the CCS, Card Sound, Biscayne Bay, and local canals. The maps indicate that they represent 2017 data. The isopleth maps unrealistically treated the separate surface water bodies like they were one contiguous surface water body. However, the main point of these maps was to illustrate that in Biscayne Bay and Card Sound, chlorophyll-a and total nitrogen concentrations increased from east to west as the CCS was approached. The chlorophyll-a isopleth map was based only on data from Biscayne Bay and Card Sound. The NRC staff and its contractors evaluated the 2016, 2017, and 2018 data available in FPL's Electronic Data Management System (EDMS; https://www.ptn-combined-monitoring.com) and in annual monitoring reports covering the same time period (FPL 2018o, FPL 2017a, FPL 2016b). However, the staff was unable to match the chlorophyll-a values in the map either from specific sampling events or yearly averaged values.

Looking at specific sampling events and yearly averages, the NRC staff and its contractors did not find a consistent trend in the data from 2016, 2017, and 2018 that were in FPL's Electronic Data Management System (EDMS; https://www.ptn-combined-monitoring.com). The NRC staff observed that moving away from the CCS, chlorophyll-a concentrations could either decrease or increase. Within Biscayne Bay, sometimes concentrations increased or decreased moving either east or west from the center of the bay, with no apparent relation to the CCS.

The isopleth map of total nitrogen used values for the CCS, Biscayne Bay, Card Sound, and local canals. The NRC staff and its contractors were able to match the values in the map for total nitrogen values used to represent Biscayne Bay and Card Sound. The match for these values came from a single sampling event on September 12, 2016. As with the chlorophyll-a data, the NRC staff and its contractors could not find a consistent trend in the data from 2016, 2017, and 2018 in FPL's Electronic Data Management System (EDMS; https://www.ptn-combined-monitoring.com).

To better characterize the water quality conditions in Biscayne Bay and Card Sound and its relationship to biologic communities, Section 3.5.1.4 of this SEIS was updated, in part, in response to these comments.

Comment: The renewal of the FPL TPPP NRC license according to the NRC environmental impact statement (EIS) is also premised on the agreement with Miami Dade WASD to build a RO reclaimed water plant for the purpose of providing FPL with the massive amounts of water required to operate the cooling canal system safely and effectively. In the interim, FPL has been permitted by the SFWMD to withdraw this water from the L31 canal and the brackish water of the Floridan, of which supply is limited because it is recharged by rainfall and artesian wells from Northern Florida and Georgia. This use of the Floridan in large quantities for this purpose adversely affects taxpayer funded Everglades Restoration projects in the area by diverting our limited water supply to the cooling canal system. If FPL is allowed to continue to use the cooling canal system, the reclaimed RO water produced by the plant will continue to leak from the canals and into the aquifer and bay. (**0024-4** [List, Gary])

Response: *The NRC's proposed action (subsequent license renewal) for Turkey Point Units 3 and 4 and its continued operation for an additional 20 years is not premised on the agreement between FPL and Miami-Dade County for use of reclaimed sanitary wastewater for CCS salinity* *reduction. Under the proposed action, the staff assumes that water for CCS freshening would continue to be withdrawn from the Upper Floridan aquifer, as described in Section 3.5.1.4 of the SEIS (see "Salinity Management Plan"). In addition, Section 3.5.2.3 of the SEIS describes the operation and quantifies the withdrawals of FPL's Upper Floridan aquifer freshening wells and Section 4.5.1.2, "Groundwater Use Conflicts" (see "Groundwater Use Conflicts (Plants That Withdraw More Than 100 Gallons per Minute")," presents an evaluation of the water use conflicts associated with the continued use of groundwater for CCS freshening and other uses under the proposed action, along with a discussion of groundwater use conflicts with other users.*

This comment provides no new information and no changes were made to the SEIS as a result.

Comment: Currently, FPL is under orders from regulators to correct problems stemming from the canals that cool the water used to run the steam turbines. Among these, the cooling canals discharge nutrient-rich, hypersaline water into Biscayne Bay and the Biscayne aquifer. The Interceptor Ditch has failed its intended function to prevent contamination of the aquifer, and its continued operation comes at the cost of extracting around 3 mgd of freshwater from the wetlands in the Model Lands area. What are the consequences for the health of the bay and success of the C-111 and Biscayne Bay Coastal Wetlands Restoration projects if the cooling canals operate for another 30 years?

Results from an expanded monitoring program, initiated in 2009, reveal how the cooling canals interact with Biscayne Bay and the regional groundwater system through an active exchange of water between the canals and the aquifer. The cooling canals were constructed in the 1970s to prevent damaging discharge of heated water directly into the bay from the Turkey Point power plants. Until about 2009 it was widely assumed that the canals had little impact on the bay and adjacent wetlands. However, by 2012, investigations demonstrated the canals were the source of a plume of hypersaline groundwater extending several miles west, and nutrient-rich water from the canals was found in the bay.

Water in the canals is hypersaline as a consequence of high rates of evaporation. Evaporation is one of the primary mechanisms that cools the heated water as it circulates through the canals from the point of discharge on the west side of the power plants, returning to the water intake on the east side of the plant. For the first 40 years of operation, an inflow of saline water from Biscayne Bay made up the difference between losses from evaporation and water added by rainfall, pumping from the Interceptor Ditch and other minor sources. As a result, salt accumulated in the canals. Since 2010, the salinity of water in the canals has averaged around 60 psu. Seepage out of the canals provides a steady supply of hypersaline water to feed the growth of the groundwater plume.

In 2016, FPL initiated actions to remediate the discharge of hypersaline water into the aquifer. In particular, fresher water is being added to the canals from the Upper Floridan aquifer to decrease the average salinity to 34 psu. And, water is being withdrawn from the groundwater plume through a series of recovery wells and pumped into a deep injection well. These actions address the factors involved in the formation and westward migration of the saline groundwater plume.\

[View pdf to see attachment w/color figures entitled "Future Impacts on Biscayne Bay of Extended Operation of Turkey Point Cooling Canals" by Laura Reynolds, James Fourqurean, and William Nuttle, available from NRC ADAMS, Accession No. ML19151A729] (**0071-1** [Reynolds, Laura])

Response: *The SEIS provides a thorough evaluation of the impacts of CCS operation on groundwater resources, surface water resources, and other resources, including CCS impacts on nearby surface waters through a groundwater pathway. The operation of CCS and its connection to and effects on surface and groundwater resources are described in Sections 3.1.3, "Cooling and Auxiliary Water Systems," 3.5.1, "Surface Water," and 3.5.2, "Groundwater Resources." The NRC staff did not revise the SEIS based on this comment.*

A.2.13 Land Use and Visual Resources

Comment: The proximity of the Turkey Point Plant location to BNP, BNP Visitor Center and Headquarters, and Homestead Bayfront Park is missing from Section 3.1.1 entitled, External Appearance and Setting (SEIS, Page 3-1) and only briefly mentioned in passing in last paragraph of Section 3.2. BNP supports nearly 500,000 visitors annually who enjoy the park for various recreational activities such as sightseeing, snorkeling, boating and fishing. The BNP Visitor Center, as well as Homestead Community Bayfront Park, have clear views of the FPL facility including Units 3 and 4. Page 3-25 of the Draft SEIS should provide additional information regarding the proximity of Turkey Point to BNP, the benefits of BNP to the local economy and communities, and a description of the visual impact of seeing the FPL facility from the water within BNP. The NPS recommends changing the impact rating for this topic from "Small" to "Moderate." (**0005-6** [Vogel, Robert])

Comment: It is recommended that all alternatives be given the same impact category assessment for visual resources because the skyline is already impacted with the existing facility. (**0031-8** [Militscher, Christopher])

Response: *As explained in Section 4.2.1 of the SEIS, nuclear power plant operations at Turkey Point Units 3 and 4 have not changed appreciably with time, and no change in land use and visual impacts are expected during the subsequent license renewal term. Therefore, people living in the vicinity of Turkey Point and visitors to the Biscayne National Park, Biscayne Bay, Homestead Bayfront Park, and the Dante Fascell Visitor Center would not experience any visual changes in the appearance of Turkey Point Units 3 and 4 during the subsequent license renewal term beyond what is currently being experienced. Section 3.2.2 points out that Turkey Point power units can be clearly seen from Biscayne National Park, including much of Biscayne Bay. Denial of the requested licensing action would not diminish the visual impacts, as the structures would remain in place for some time, before eventually being dismantled, as discussed in Section 4.2.2.2 (no-action alternative/visual resources). The comments did not introduce any new information that has not already been considered in the analysis. No changes were made to the SEIS as a result of these comments.*

Comment: Section 4.2.7.1, Page 4-11. The DSEIS states, "land use impacts associated with the construction and operation of the mechanical draft cooling towers for the cooling water system alternative would be SMALL." The DSEIS should recognize that, with much of the Turkey Point site occupied by the existing generation facilities, the cooling canal system, and wetlands, the footprint for cooling towers should be expected to impact wetlands and require permits and mitigation. The proposed location of the cooling towers and new Waste Water Treatment Facility would likely require wetland mitigation due to the need to establish a large construction site area that would be required for material and equipment laydown and staging in conjunction with the footprints of the new Cooling Towers, Waste Water Treatment Facility, Make-Up Water Pond (which is calculated at 60 Acres), and new pumping station. This statement should be revised to indicate that the land use impacts for this alternative would likely be larger than described in the DSEIS. (**0017-4-3** [Maher, William])

APPENDIX E
ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

This section describes the environmental impacts from postulated accidents that may occur at Turkey Point Nuclear Generating Unit Nos. 3 and 4 (Turkey Point, or Turkey Point Units 3 and 4) during the subsequent license period. The term "accident" refers to any unintentional event outside the normal plant operational envelope that could result in either (a) an unplanned release of radioactive materials into the environment or (b) the potential for an unplanned release of radioactive materials into the environment. NUREG–1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS) (NRC 1996, 2013a), evaluates in detail the following two classes of postulated accidents as they relate to license renewal:

- Design-Basis Accidents: Postulated accidents that a nuclear facility must be designed and built to withstand without loss to the systems, structures, and components necessary to ensure public health and safety.
- Severe Accidents: Postulated accidents that are more severe than design-basis accidents because they could result in substantial damage to the reactor core, whether or not there are serious off-site consequences.

This section first describes the evaluation of new and significant information as it relates to design-basis accidents, followed by an evaluation of new and significant information for severe accidents.

E.1 Background

Although this supplemental environmental impact statement documents the NRC staff's review of a subsequent license renewal application, it is helpful to keep in mind that long before any license renewal actions, an operating reactor has already completed the NRC licensing process for the original 40-year operating license. To receive a license to operate a new nuclear power reactor, an applicant must submit to the NRC an operating license application that includes, among many other requirements, a safety analysis report. The applicant's safety analysis report presents the design criteria and design information for the proposed reactor and includes comprehensive data on the proposed site. The applicant's safety analysis report also describes various design-basis accidents and the safety features designed to prevent or mitigate their impacts. The NRC staff reviews the operating license application to determine if the plant's design—including designs for preventing or mitigating accidents—meet the NRC's regulations and requirements.

E.1.1 Design-Basis Accidents

Design-basis accidents are postulated accidents that a nuclear facility must be designed and built to withstand without loss to the systems, structures, and components necessary to ensure public health and safety. Planning for design-basis accidents ensures that the proposed plant can withstand normal transients (rapid changes in the reactor coolant system temperature or pressure, or rapid changes in reactor power), as well as a broad spectrum of postulated accidents without undue hazard to the health and safety of the public. Many of these design-basis accidents may occur, but are unlikely to occur even once during the life of the plant; nevertheless, carefully evaluating each design-basis accident is crucial to establishing the design basis for the preventive and mitigative safety systems of the proposed nuclear power plant. Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," and 10 CFR Part 100, "Reactor Site Criteria," describe the NRC's acceptance criteria for design-basis accidents.

Before the NRC will issue an operating license for a new nuclear power plant, the applicant must demonstrate the ability of its proposed reactor to withstand all design-basis accidents. The applicant and the NRC staff evaluate the environmental impacts of design-basis accidents for the hypothetical maximum-exposed individual. The results of these evaluations of design-basis accidents are found in the reactor's original licensing documents such as the applicant's final safety analysis report, the NRC staff's safety evaluation report, and the final environmental statement (FES). Once the NRC issues the operating license for the new reactor, the licensee is required to maintain the acceptable design and performance criteria (which includes withstanding design-basis accidents) throughout the operating life of the nuclear power plant, including any license renewal periods of extended operation. The consequences for these events are evaluated for the hypothetical maximum exposed individual; as such, changes in the plant environment will not affect these evaluations.

Pursuant to 10 CFR 54.29(a), license renewal applicants are required to manage the effects of aging and perform any required time-limited aging analyses (as further described in the regulation), such that there is reasonable assurance that the activities authorized by the renewed license will continue to be conducted in accordance with the plant's current licensing basis (CLB) and any changes made to the plant's CLB in order to comply with section 54.29 are in accordance with the Atomic Energy Act and the Commission's regulations. In other words, because of the requirements that the existing design-basis and aging management programs be in effect for license renewal, the environmental impacts of design-basis accidents as calculated for the original operating license application should not differ significantly from the environmental impacts of design-basis accidents at any other time during plant operations, including during the initial license renewal and subsequent renewal periods. Accordingly, the design of the nuclear power plant, relative to design-basis accidents during the period of extended operation, is considered to remain acceptable.

E.1.2 Design-Basis Accidents and License Renewal

The early identification and resolution of the design-basis accidents (prior to subsequent license renewal) makes them a part of the current licensing basis (CLB) of the plant. The NRC requires licensees to maintain the CLB of the plant under the current operating license, as well as during any license renewal period. Therefore, under the provisions of 10 CFR 54.30, "Matters not Subject to a Renewal Review," design-basis accidents are not subject to review under license renewal.

As stated in Section 5.3.2 of the 1996 GEIS, the environmental impact from design-basis accidents was assessed in the individual plant-specific EISs at the time of the initial license application review. Since the licensee is required to maintain the plant within acceptable design and performance criteria, including during any license renewal term, these environmental impacts are not expected to change significantly. Therefore, additional assessment of the environmental impacts from design-basis accidents is not necessary (NRC 2013a).

The GEIS concludes that the environmental impacts of design-basis accidents are of SMALL significance for all nuclear power plants, because the plants were designed to successfully withstand these accidents. For the purposes of initial or subsequent license renewal, the NRC designates design-basis accidents as a Category 1 generic issue—applicable to all nuclear power plants (see 10 CFR Part 51, Subpart A, Appendix B, Table B-1, "Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants"). During the license renewal review process, the NRC staff adopts the applicable Category 1 issue conclusions from the GEIS (unless there exists new and significant information about the issue). Hence, the NRC staff need not address most Category 1 issues (like design-basis accidents) in the site-specific supplemental environmental impact statement for license renewal, in the absence of new and significant information pertinent to those issues.

In its environmental report for the Turkey Point subsequent license renewal application, Florida Power & Light Company (FPL) did not identify any new and significant information related to design-basis accidents at Turkey Point (FPL 2018f). The NRC staff also did not identify any new and significant information related to design-basis accidents during its independent review of FPL's environmental report, through the scoping process, or in its evaluation of other available information. Therefore, the NRC staff concludes that there are no environmental impacts related to design-basis accidents at Turkey Point during the subsequent license renewal period beyond those already discussed generically for all nuclear power plants in the GEIS.

E.1.3 Severe Accidents

Severe accidents are postulated accidents that are more severe than design-basis accidents because severe accidents can result in substantial damage to the reactor core, whether or not there are serious offsite consequences. Severe accidents can entail multiple failures of equipment or function. The likelihood of a severe accident occurring is generally even lower than the likelihood of a design-basis accident occurring.

E.1.4 Severe Accidents and License Renewal

Chapter 5 of the 1996 GEIS (NUREG-1437) conservatively predicts the environmental impacts of postulated severe accidents that may occur during the period of extended operations at nuclear power plants. In the 2013 GEIS, the staff updated the NRC's 1996 plant-by-plant severe accident environmental impact assessments (NRC 2013a, Appendix E). In the GEIS, the impacts of severe accidents that were considered include:

- dose and health effects of accidents
- economic impacts of accidents
- effect of uncertainties on the results

The NRC staff calculated these estimated impacts by studying the risk analysis of severe accidents as reported in the environmental impact statements (EISs) and/or final environmental statements that the NRC staff had prepared for each of the plants in support of their original reactor operating licenses. When the NRC staff prepared the 1996 GEIS, 28 nuclear power plant sites (44 units) had EISs or FESs that contained a severe accident analysis. Not all original operating reactor licenses contain a severe accident analysis since the NRC has not always required such analyses. The 1996 GEIS assessed the impacts of severe accidents during the license renewal period, using the results of existing analyses and site-specific information to conservatively predict the environmental impacts of severe accidents for all plants during the renewal period. With few exceptions, the severe accident analyses evaluated in the 1996 GEIS were limited to consideration of reactor accidents caused by internal events. The 1996 GEIS addressed the impacts from external events qualitatively.

For its severe accident environmental impact analysis for each plant, the 1996 GEIS used very conservative 95th percentile upper confidence bound estimates for environmental impact whenever available. This approach provides conservatism to cover uncertainties, as described in Section 5.3.3.2.2 of the 1996 GEIS. The 1996 GEIS concluded that the probability-weighted impacts of severe accidents as related to license renewal are small compared to other risks to which the populations surrounding nuclear power plants are routinely exposed. The NRC's understanding of severe accident risk has continued to evolve since it issued the 1996 GEIS. The updated 2013 GEIS assesses more recent information and developments in severe accident analyses and how they might affect the conclusions in Chapter 5 of the 1996 GEIS. The 2013 GEIS also provides comparative data where appropriate. Based on information in the 2013 GEIS, the NRC staff determined that for all nuclear power plants, the probability-weighted consequences of severe accidents are SMALL. However, the GEIS determined that alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives, as a Category 2 issue. See Table B-1, "Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants," of Appendix B to Subpart A of 10 CFR Part 51, which states:

> The probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are SMALL for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives.

An analysis of severe accident mitigation alternatives was performed for Turkey Point at the time of initial license renewal. The staff documented its review in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," Supplement 5, Regarding Turkey Point Nuclear Plant, Units 3 & 4. Any new and significant information that might alter the conclusions of that analysis was considered for subsequent license renewal, as discussed below.

E.2 Severe Accident Mitigation Alternatives

In a SAMA analysis, the NRC requires license renewal applicants to consider the environmental impacts of severe accidents, their probability of occurrence, and potential means available to mitigate those accidents. As quoted above, 10 CFR Part 51, Table B-1 states "alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives." This NRC requirement to consider alternatives to mitigate severe accidents can be fulfilled by a severe accident mitigation alternatives (SAMA) analysis. The purpose of the SAMA analysis is to identify design alternatives, procedural modifications, or training activities that may further reduce the risks of severe accidents at nuclear power plants and that are also potentially cost beneficial to implement. The SAMA analysis includes the identification and evaluation of SAMAs that may reduce the radiological risk from a severe accident by preventing substantial core damage (i.e., preventing a severe accident) or by limiting releases from containment in the event that substantial core damage occurs (i.e., mitigating the impacts of a severe accident) (NRC 2013b). The regulations at 10 CFR 51.53(c)(3)(ii)(L) state that each license renewal applicant must submit an environmental report that considers alternatives to mitigate severe accidents, "If the staff has not previously considered severe accident mitigation alternatives for the applicant's plant in an environmental impact statement or related supplement or in an environmental assessment."

E.2.1 Turkey Point Initial License Renewal Application and SAMA Analysis in 2000

As part of its initial license renewal application submitted in 2000, FPL's environmental report included an analysis of SAMAs for Turkey Point Units 3 and 4 (FPL 2000). FPL based this SAMA analysis on (1) the Turkey Point probabilistic safety assessment (PSA) for total accident frequency, core damage frequency (CDF), and containment large early release frequency (LERF), and (2) a supplemental analysis of offsite consequences and economic impacts for risk determination. The Turkey Point PSA included a Level 1 analysis to determine the CDF from internally initiated events and a Level 2 analysis to determine containment performance during severe accidents. The offsite consequences and economic impacts analyses used the MELCOR Accident Consequence Code System 2 (MACCS2) code, Version 1.2, to determine the offsite risk impacts on the surrounding environment and the public. Inputs for the latter analysis included plant/site-specific values for core radionuclide inventory, source term and release fractions, meteorological data, projected population distribution (based on 1990 census data, projected out to 2025), emergency response evacuation modeling, and economic data. To help identify and evaluate potential SAMAs, FPL considered insights and recommendations from SAMA analyses for other plants, potential plant improvements discussed in NRC and industry documents, and documented insights provided by Turkey Point staff.

In its 2000 environmental report, FPL considered 167 SAMAs. FPL then performed a qualitative screening of those SAMAs, eliminating SAMAs that were not applicable to Turkey Point or had already been implemented at Turkey Point (or the design met the intent of the SAMA). Based on this qualitative screening, 91 SAMAs were eliminated, leaving 76 subject to the final screening and evaluation process. Of the 91 SAMAs eliminated, 64 were eliminated because they had already been implemented at Turkey Point (or the design met the intent of the SAMA), while 27 SAMAs were eliminated because they were not applicable to Turkey Point. The 76 remaining SAMAs were listed in Table F.2-2 of Appendix F of the 2000 ER (FPL 2000). The final screening process involved identifying and eliminating those SAMAs whose cost exceeded twice their benefit. Ultimately, FPL concluded that there were no potentially cost-beneficial SAMAs associated with the initial Turkey Point license renewal (FPL 2000).

As part of the NRC staff's review of the initial Turkey Point license renewal application, the staff reviewed FPL's analysis of SAMAs for Turkey Point Units 3 and 4 and documented this review in its SEIS, which the NRC published in January 2002 as Supplement 5, "Regarding Turkey Point Nuclear Plant, Units 3 & 4," to NUREG–1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (NRC 2002c). Chapter 5 of Supplement 5 to NUREG-1437 contains the NRC staff's evaluation of the potential environmental impacts of plant accidents and examines each SAMA (individually and, in some cases, in combination) to determine the SAMA's individual risk reduction potential. The NRC staff then compared this potential risk reduction against the cost of implementing the SAMA to quantify the SAMA's cost-benefit value.

In Section 5.2 of its 2002 SEIS for the initial Turkey Point license renewal (NUREG-1437, Supplement 5), the NRC staff found that FPL used a systematic and comprehensive process for identifying potential plant improvements for Turkey Point Units 3 and 4, and that its bases for calculating the risk reductions afforded by these plant improvements were reasonable and generally conservative. Further, the NRC staff found that FPL's estimates of the costs of implementing each SAMA were reasonable and consistent with estimates developed for other operating reactors. In addition, the NRC staff concluded that FPL's cost-benefit comparisons were performed appropriately. The NRC staff concluded that FPL's SAMA methods and implementation of those methods were sound, and it agreed with FPL's conclusion that none of the candidate SAMAs were potentially cost beneficial based on conservative treatment of costs and benefits. The staff found FPL's conclusion consistent with the low residual level of risk indicated in the Turkey Point probabilistic safety assessment, and was also consistent with the fact that Turkey Point had already implemented many plant improvements identified during two risk analysis processes: (1) the individual plant examination or IPE (a risk analysis that considers the unique aspects of a particular nuclear power plant, identifying the specific vulnerabilities to severe accident of that plant) and (2) the individual plant examination for external events or IPEEE (a risk analysis that considers external events such as earthquakes, internal fires, and high winds) (NRC 2002c).

E.2.2 Turkey Point 2018 Subsequent License Renewal Application and New and Significant Information as it Relates to the Probability-Weighted Consequences of Severe Accidents

As mentioned above, a license renewal application must include an environmental report that describes SAMAs if the NRC staff has not previously evaluated SAMAs for that plant in an environmental impact statement (EIS), in a related supplement to an EIS, or in an environmental assessment. As also discussed above, the NRC staff performed a site-specific analysis of Turkey Point SAMAs in a supplement to an EIS (Supplement 5, "Regarding Turkey Point Nuclear Plant, Units 3 & 4," to NUREG–1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants") (NRC 2002c). Therefore, in accordance with 10 CFR 51.53(c)(3)(ii)(L) and Table B-1 of Appendix B to Subpart A of 10 CFR Part 51, FPL is not required to provide another SAMA analysis in its environmental report for the Turkey Point subsequent license renewal application.

The NRC's regulations in 10 CFR Part 51, which implement Section 102(2) of the National Environmental Policy Act (NEPA), require that all applicants for license renewal submit an environmental report to the NRC, in which they identify any ''new and significant information regarding the environmental impacts of license renewal of which the applicant is aware'' (10 CFR 51.53(c)(3)(iv)). This includes new and significant information that could affect the environmental impacts related to postulated severe accidents or that could affect the results of a previous SAMA analysis. Accordingly, in its subsequent license renewal application environmental report, FPL evaluates areas of new and significant information that could affect the environmental impact of postulated severe accidents during the subsequent license renewal period of extended operation, and possible new and significant information as it relates to SAMAs.

In FPL's assessment of new and significant information related to SAMAs in its SLR application, FPL utilized guidance that was recently issued by the Nuclear Energy Institute (NEI), which the NRC staff has endorsed. As discussed in Section E-5 below, NEI developed a model approach for license renewal applicants to use in assessing the significance of new information of which the applicant is aware, that relates to a prior SAMA analysis that was performed in support of the issuance of an initial license, renewed license, or combined license (COL). This effort led to the publication of NEI 17-04, "Model SLR New and Significant Assessment Approach for SAMA, Rev. 0," on June 29, 2017 (NEI 2017). NEI 17-04 provides a tiered approach that entails a 3-stage screening process for the evaluation of new information. In this screening process, new information is deemed to be "potentially significant" to the extent that it results in the identification in Stage 1 (involving the use of PRA risk insights and/or risk model quantifications) of an unimplemented SAMA that reduces the maximum benefit by 50 percent or more. If a SAMA is found to result in a 50 percent reduction in maximum benefit in Stage 1, a Stage 2 assessment would then be performed (involving an updated averted cost-risk estimate for implementing that SAMA). A Stage 3 assessment (involving a cost-benefit analysis) would be required only for “potentially significant” SAMAs, i.e., those that are shown by the Stage 2 assessment to reduce the maximum benefit by 50 percent or more. Finally, if the Stage 3 assessment shows that a “potentially significant” SAMA is “potentially cost-beneficial,” thus indicating the existence of “new and significant” information, then the applicant must supplement the previous SAMA analysis. The NRC endorsed NEI 17-04 for use by license renewal applicants on January 31, 2018 (NRC 2018m). FPL’s assessment of new and significant information related to its SAMA cost-benefit analysis is discussed in Section E.5 of this Appendix.

Below, the NRC staff summarizes FPL’s description of possible areas of new and significant information and assesses FPL’s conclusions.

E.3 Evaluation of New Information Concerning Severe Accident Consequences for Turkey Point as it relates to the GEIS and the 2002 Turkey Point SEIS.

The 2013 GEIS considers developments in plant operation and accident analysis that could have changed the assumptions made in the 1996 GEIS concerning severe accident consequences. The 2013 GEIS confirmed the determination in the 1996 GEIS that the probability-weighted consequences of severe accidents are small for all plants. In the 2013 GEIS, Appendix E provides the NRC staff’s evaluation of the environmental impacts of postulated accidents. Table E-19, “Summary of Conclusions,” shows the developments that the NRC staff considered as well as the staff’s conclusions. Consideration of the listed items was the basis for the NRC staff's overall determination in the 2013 GEIS that the probability-weighted consequences of severe accidents remain small for all plants.

For subsequent license renewal for Turkey Point, the staff confirmed that there is no new and significant information that would change the 2013 GEIS or the 2002 Turkey Point SEIS conclusions on the consequences of severe accidents. The NRC staff evaluated FPL’s information related to the 2013 GEIS, Table E-19, “Summary of Conclusions,” during the onsite Turkey Point audit and by reviewing docketed information (NRC 2018c). The results of that review follow.

E.3.1 New Internal Events Information (Section E.3.1 of the 2013 GEIS)

After FPL submitted the Turkey Point initial license renewal application environmental report in 2000 and the NRC issued its corresponding SAMA review in its 2002 SEIS, there have been many improvements to Turkey Point’s risk profile. The Turkey Point internal events core damage frequency in the initial license renewal SAMA was approximately 1.6×10^{-5}/year. The current Turkey Point internal events probabilistic risk assessment (PRA) model of record has a core damage frequency of approximately 7.0×10^{-7}/year. This change represents a 96-percent reduction or a factor-of-23 reduction in core damage frequency for each unit. This substantial improvement in CDF makes any proposed new SAMA or previously evaluated SAMA less likely to be cost beneficial.

In the 2013 GEIS, the NRC staff reviewed the updated boiling-water reactor (BWR) and pressurized-water reactor (PWR) internal event core damage frequencies (CDFs). The CDF is an expression of the likelihood that, given the way a reactor is designed and operated, an accident could cause the fuel in the reactor to be damaged. The 2013 GEIS addresses new information on the risk and environmental impacts of severe accidents caused by internal events which had emerged following issuance of the 1996 GEIS and included consideration of

Turkey Point's plant-specific PRA analysis. The new information addressed in the 2013 GEIS indicates that PWR and BWR CDFs evaluated for the 2013 GEIS are generally comparable to or less than the CDFs that formed the basis of the 1996 GEIS (NRC 2013a).

Therefore, the NRC staff concludes that the offsite consequences of severe accidents initiated by internal events during the subsequent license renewal term would not exceed the impacts predicted in the 2013 GEIS. For these issues, the GEIS predicted that the impacts would be SMALL for all nuclear plants. The NRC staff identified no new and significant information regarding internal events during its review of FPL's environmental report, during the SAMA audit, through the scoping process, or through the evaluation of other available information. Thus, the NRC staff agrees with FPL's conclusion that no new and significant information exists for Turkey Point concerning offsite consequences of severe accidents initiated by internal events that would alter the conclusions reached in the 2013 GEIS or Turkey Point's previous SAMA analysis.

E.3.2 External Events (Section E.3.2 of the 2013 GEIS)

Section E.3.2.3 of the 2013 GEIS concludes that the CDFs from severe accidents initiated by external events, as quantified in NUREG–1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," (NRC 1990) and other sources, are comparable to CDFs from accidents initiated by internal events but lower than the CDFs that formed the basis for the 1996 GEIS. In the 2013 GEIS, the environmental impacts from externally initiated events are generally significantly lower—one or more orders of magnitude lower—than the environmental impacts from external events determined in the 1996 GEIS.

The 1996 GEIS concluded that severe accidents initiated by external events (such as earthquakes, floods, or fires) could have potentially high consequences but also found that the risks from these external events are adequately addressed through a consideration of severe accidents initiated by internal events (such as a loss of cooling water). Therefore, the 1996 GEIS concluded that an applicant for license renewal need only analyze the environmental impacts from an internal event to characterize the environmental impacts from either internal or external events.

External Events: Seismic

In 2014, FPL performed a bounding seismic evaluation for Turkey Point using appropriate seismic hazard curves and a plant-level fragility curve. This bounding seismic evaluation demonstrated that the seismic risk at Turkey Point is not significant. By letter dated January 22, 2016 (NRC 2016b), the NRC staff documented its review of FPL's Turkey Point reevaluated seismic hazard, also referred to as the mitigating strategies seismic hazard information. The staff confirmed FPL's conclusion that the Turkey Point reevaluated seismic hazard is bounded by the current design basis at all frequencies above 1 Hertz (Hz). In addition, in the staff's letter of June 16, 2016, the staff concluded that the FPL-determined ground motion response spectrum adequately characterizes the reevaluated seismic hazard for the Turkey Point site (NRC 2016b). For more detail, see the NRC staff's June 16, 2016 letter, "Turkey Point Nuclear Generating, Unit Nos. 3 And 4—Staff Review of Mitigation Strategies Assessment Report of the Impact of the Reevaluated Seismic Hazard Developed in Response to the March 12, 2012, [10 CFR] 50.54(F) Letter (CAC Nos. MF7886 and MF7887)" (NRC 2016c). Thus, the NRC staff agrees with FPL's statement in its 2018 environmental report for Turkey Point subsequent license renewal, that Turkey Point does not require an updated seismic probabilistic risk assessment for subsequent license renewal.

External Events: Fire

By letter dated May 28, 2015, the NRC approved amendments modifying the Turkey Point Units 3 and 4 operating licenses and technical specifications to incorporate a new fire protection licensing basis in accordance with 10 CFR 50.48(c), “Fire Protection.” The amendments authorized the transition of Turkey Point’s fire protection program to a risk-informed and performance-based program based on the 2001 edition of National Fire Protection Association Standard 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants" (NRC 2015d]). FPL used the Fire PRA for consideration of the reduction in benefit for the fire-related SAMAs in the Turkey Point subsequent license renewal application environmental report.

In conclusion, there was a greater-than-a-factor-of-20 decrease in the Turkey Point internal events CDF and seismic risk for Turkey Point was determined to be insignificant. Therefore, the offsite consequences of severe accidents initiated by external events during the subsequent license renewal term would not exceed the impacts predicted in the GEIS. For these issues, the GEIS predicts that the impacts would be SMALL for all nuclear plants. The NRC staff identified no new and significant information regarding external events during its review of FPL’s environmental report, through the SAMA audit, during the scoping process, or through the evaluation of other available information. Thus, the NRC staff agrees with FPL’s conclusion that no new and significant information exists for Turkey Point concerning offsite consequences of severe accidents initiated by external events that would alter the conclusions reached in the 2013 GEIS or Turkey Point’s previous SAMA analysis.

E.3.3 New Source Term Information (Section E.3.3 of the 2013 GEIS)

The source term refers to the magnitude and mix of the radionuclides released from the fuel (expressed as fractions of the fission product inventory in the fuel), as well as their physical and chemical form, and the timing of their release following an accident. The 2013 GEIS concludes that, in most cases, more recent estimates give significantly lower release frequencies and release fractions than was assumed in the 1996 GEIS. Thus, the environmental impacts of radioactive materials released during severe accidents, used as the basis for the 1996 GEIS (i.e., the frequency-weighted release consequences), are higher than the environmental impacts that would be estimated today using more recent source term information. The staff also notes that results from the NRC’s State-of-the-Art Reactor Consequence Analysis (SOARCA) project (which represents a significant ongoing effort to re-quantify realistic severe accident source terms) confirm that source term timing and magnitude values calculated in the SOARCA reports are significantly lower than source term values quantified in previous studies. The NRC staff expects to incorporate the information gleaned from the SOARCA project in future revisions of the GEIS.

For the reasons described above, current source term timing and magnitude at Turkey Point is likely to be significantly lower than had been quantified in previous studies and the initial license renewal Turkey Point SAMA analysis in 2000. Therefore, the offsite consequences of severe accidents initiated with the new source term during the subsequent license renewal term would not exceed the impacts predicted in the GEIS. For these issues, the GEIS predicts that the impacts would be SMALL for all nuclear plants. The NRC staff identified no new and significant information regarding internal events during its review of FPL’s environmental report, through the SAMA audit, during the scoping process, or through the evaluation of other available information. Thus, the NRC staff agrees with FPL’s conclusion that no new and significant information exists for Turkey Point concerning offsite consequences of severe accidents initiated by internal events that would alter the conclusions reached in the 2013 GEIS or Turkey Point's previous SAMA analysis.

E.3.4 Power Uprate Information (Section E.3.4 of the 2013 GEIS)

Operating at a higher reactor power level results in a larger fission product radionuclide inventory in the core than if the reactor were operating at a lower power level. In the event of an accident, the larger radionuclide inventory in the core would result in a larger source term. If the accident is severe, this larger source term could result in higher doses to offsite populations.

Large early release frequency (LERF) represents the frequency of sequences that result in early fatalities. The impact of a power uprate on early fatalities can be measured by considering the impact of the uprate on the LERF calculated value. To this end, Table E-14 of the 2013 GEIS presents the change in LERF calculated by each licensee that has been granted a power uprate of greater than 10 percent. As can be seen, the increase in LERF ranges from a minimal impact to an increase of about 30 percent (with a mean of 10.5 percent). The 2013 GEIS, Section E.3.4.3, "Conclusion," determines that power uprates will result in a small to (in some cases) moderate increase in the environmental impacts from a postulated accident. However, taken in combination with the other information presented in the GEIS, the increases would be bounded by the 95 percent upper confidence bound values in Table 5.10 and Table 5.11 of the 1996 GEIS.

In 2012, the NRC approved a 15 percent power uprate for Turkey Point, which included a 13 percent increase in core thermal power and a 1.7 percent measurement uncertainty recapture, from 2,300 megawatts thermal (MWt) to 2644 MWt. Before the extended power uprate, FPL calculated the Turkey Point Unit 4 internal events LERF to be $1.3\text{x}10^{-8}$/year. After the extended power uprate, FPL conservatively projected the Unit 4 LERF to be $1.8\text{x}10^{-8}$/year. This is a change of $4.3\text{x}10^{-9}$/year, or an increase in LERF of about 32 percent. The NRC staff's safety evaluation for this extended power uprate at Turkey Point states that this increase in LERF falls within the acceptance guidelines for being "very small" (i.e., less than $1\text{x}10^{-7}$ per reactor year), set forth in Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment In Risk Informed Decisions on Plant Specific Changes to the Licensing Basis," and therefore does not raise any concerns of adequate protection (NRC 2012). Accordingly, even though the change in LERF is slightly greater than 30 percent (upper percentage increase in LERF determined in the updated 2013 GEIS), the staff finds this change to be a very small impact due to the very small change in LERF as defined in RG 1.174.

In sum, the staff finds the conclusions of the 2013 GEIS on this topic appropriate for the Turkey Point subsequent license renewal application, considering that there was a "very small" (less than $1\text{x}10^{-7}$ per reactor year) change in LERF, the increases would be bounded by the 95 percent upper confidence bound values in Table 5.10 and Table 5.11 of the 1996 GEIS and Turkey Point had a greater-than-a-factor-of-20 decrease in the internal events CDF from the original SAMA to the subsequent license renewal application (which lowers the LERF). Therefore, the offsite consequences from the power uprate would not exceed the impacts predicted in the GEIS. For these issues, the GEIS predicted that the impacts would be SMALL to MODERATE for all nuclear plants. The NRC staff has identified no new and significant information regarding power uprates during its review of FPL's environmental report, through the SAMA audit, during the scoping process, or through the evaluation of other available information. Thus, the NRC staff agrees with FPL's conclusion that no new and significant information exists for Turkey Point concerning offsite consequences due to power uprates that would alter the conclusions reached in the 2013 GEIS or Turkey Point's previous SAMA analysis.

E.3.5 Higher Fuel Burnup Information (Section E.3.5 of the 2013 GEIS)

According to the 2013 GEIS, increased peak fuel burnup from 42 to 75 gigawatt days per metric ton uranium (GWd/MTU) for PWRs, and 60 to 75 GWd/MTU for BWRs, results in small to moderate increases (up to 38 percent) in environmental impacts in the event of a severe accident. However, taken in combination with the other information presented in the 2013 GEIS, the increases would be bounded by the 95 percent upper confidence bound values in Table 5.10 and Table 5.11 of the 1996 GEIS.

FPL's environmental report, Section 2.2.1, "Reactor and Containment Systems," states that both Units 3 and 4 are licensed for fuel that is slightly enriched uranium dioxide (i.e., fuel that is up to 5 percent by weight uranium-235). FPL operates the reactors at an equilibrium core maximum fuel discharge burnup rate of 62 GWd/MTU (NRC 2018e). Therefore, the updated estimates of offsite consequences remained within the bounds of the 1996 GEIS evaluation (NRC 2013a).

Therefore, the offsite consequences from higher fuel burnup would not exceed the impacts predicted in the 2013 GEIS. For these issues, the GEIS predicted that the impacts would be SMALL for all nuclear plants. The NRC staff identified no new and significant information regarding higher fuel burnup during its review of FPL's environmental report, SAMA audit, the scoping process, or the evaluation of other available information. Thus, the staff agrees with FPL's conclusion that no new and significant information exists for Turkey Point concerning offsite consequences due to higher fuel burnup that would alter the conclusions reached in the 2013 GEIS or Turkey Point's previous SAMA analysis.

E.3.6 Low Power and Reactor Shutdown Event Information (Section E.3.6 of the 2013 GEIS)

The 2013 GEIS concludes that the environmental impacts from accidents at low-power and shutdown conditions are generally comparable to those from accidents at full power, based on a comparison of the values in NUREG/CR–6143, "Evaluation of Potential Severe Accidents During Low Power and Shutdown Operations at Grand Gulf, Unit 1," (NRC 1995a) and NUREG/CR–6144, "Evaluation of Potential Severe Accidents During Low Power and Shutdown Operations at Surry, Unit 1," (NRC 1995b), with the values in NUREG–1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants" (NRC 1990). The 1996 GEIS estimates of the environmental impact of severe accidents bound the potential impacts from accidents at low power and shutdown, with margin. There are no plant configurations in low power and shutdown conditions that would distinguish Turkey Point from the evaluated plants such that the assumptions in the 2013 and 1996 GEISs would not apply.

Finally, as discussed in SECY-97-168, "Issuance for Public Comment of Proposed Rulemaking Package for Shutdown and Fuel Storage Pool Operation" (NRC 1997), industry initiatives taken during the early 1990s have also contributed to the improved safety of low-power and shutdown operations for all plants. Therefore, the offsite consequences of severe accidents, considering low-power and reactor shutdown events, would not exceed the impacts predicted in the 1996 or 2013 GEIS. For these issues, the GEIS predicts that the impacts would be SMALL for all nuclear plants. The NRC staff identified no new and significant information regarding low-power and reactor shutdown events during its review of FPL's environmental report, through the NRC staff's SAMA audit, during the scoping process, or through the evaluation of other available information. Thus, the staff agrees with FPL's conclusion that no new and significant information exists for Turkey Point concerning low-power and reactor shutdown events that would alter the conclusions reached in the 2013 GEIS or Turkey Point's previous SAMA analysis.

E.3.7 Spent Fuel Pool Accident Information (Section E.3.7 of the 2013 GEIS)

The 2013 GEIS concludes that the environmental impacts from accidents involving spent fuel pools (as quantified in NUREG–1738, "Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants" (NRC 2001)), can be comparable to those from reactor accidents at full power (as estimated in NUREG–1150 (NRC 1990)). Subsequent analyses performed, and mitigative measures employed since 2001, have further lowered the risk of this class of accidents. In addition, even the conservative estimates from NUREG–1738 are much lower than the impacts from full power reactor accidents estimated in the 1996 GEIS. Therefore, the environmental impacts stated in the 1996 GEIS bound the impact from spent fuel pool accidents for all plants. For these issues, the GEIS predicts that the impacts would be SMALL for all nuclear plants. There are no spent fuel configurations that would distinguish Turkey Point from the evaluated plants such that the assumptions in the 2013 and 1996 GEISs would not apply. The NRC staff identified no new and significant information regarding spent fuel pool accidents during its review of FPL's environmental report, the SAMA audit, the scoping process, or the evaluation of other available information. Thus, the NRC staff agrees with FPL's conclusion that no new and significant information exists for Turkey Point concerning spent fuel pool accidents that would alter the conclusions reached in the 2013 GEIS or Turkey Point's previous SAMA analysis.

E.3.8 Use of Biological Effects of Ionizing Radiation (BEIR)-VII Risk Coefficients (Section E.3.8 of the 2013 GEIS)

In 2005, the NRC staff completed a review of the National Academy of Sciences report, "Health Risks from Exposure to Low Levels of Ionizing Radiation: Biological Effects of Ionizing Radiation (BEIR) VII, Phase 2" (BEIR VII 2005). The staff documented its findings in SECY-05-0202, "Staff Review of the National Academies Study of the Health Risks from Exposure to Low Levels of Ionizing Radiation (BEIR VII)" (NRC 2005a). The SECY paper states that the NRC staff agrees with the BEIR VII report's major conclusion—namely, the current scientific evidence is consistent with the hypothesis that there is a linear, no-threshold, dose response relationship between exposure to ionizing radiation and the development of cancer in humans. The BEIR VII conclusion is consistent with the hypothesis on radiation exposure and human cancer that the NRC uses to develop its standards of radiological protection. Therefore, the NRC staff has determined that the conclusions of the BEIR VII report do not warrant any change in the NRC's radiation protection standards and regulations, which are adequately protective of public health and safety and will continue to apply during Turkey Point's subsequent license renewal term. This general topic is discussed further in the NRC's 2007 denial of Petition for Rulemaking (PRM)-51-11, which found no need to modify the 1996 GEIS in light of the BEIR VII report. For these issues, the GEIS predicts that the impacts of using the BEIR VII Risk Coefficients would be SMALL for all nuclear plants.

The NRC staff has identified no new and significant information regarding the risk coefficient used in the BEIR VII report during its review of FPL's environmental report, the SAMA audit, the scoping process, or the evaluation of other available information. Thus, the staff concludes that no new and significant information exists for Turkey Point concerning the biological effects of ionizing radiation that would alter the conclusions reached in the 2013 GEIS or Turkey Point's previous SAMA analysis.

E.3.9 Uncertainties (Section E.3.9 of the 2013 GEIS)

Section 5.3.3 in the 1996 GEIS provides a discussion of the uncertainties associated with the analysis in the GEIS and in the individual plant EISs used to estimate the environmental impacts of severe accidents. The 1996 GEIS used 95th percentile upper confidence bound estimates whenever available for its estimates of the environmental impacts of severe accidents. This approach provides conservatism to cover uncertainties, as described in Section 5.3.3.2.2 of the 1996 GEIS. Many of these same uncertainties also apply to the analysis used in the 2013 GEIS update. As discussed in Sections E.3.1 through E.3.8 of the 2013 GEIS, the GEIS update used more recent information to supplement the estimate of environmental impacts contained in the 1996 GEIS. In effect, the assessments contained in Sections E.3.1 through E.3.8 of the 2013 GEIS provided additional information and insights into certain areas of uncertainty associated with the 1996 GEIS. However, as provided in the 2013 GEIS, the impact and magnitude of uncertainties, as estimated in the 1996 GEIS, bound the uncertainties introduced by the new information and considerations addressed in the 2013 GEIS. Accordingly, in the 2013 GEIS, the staff concluded that the reduction in environmental impacts resulting from the use of new information (since the 1996 GEIS analysis) outweighs any increases in impact resulting from the new information. As a result, the findings in the 1996 GEIS remain valid. The NRC staff has identified no new and significant information regarding uncertainties during its review of FPL's environmental report, the SAMA audit, the scoping process, or the evaluation of other available information. Accordingly, the NRC staff concludes that no new and significant information exists for Turkey Point concerning uncertainties that would alter the conclusions reached in the 2013 GEIS or Turkey Point's previous SAMA analysis.

Section E.3.9.2 of Appendix E to the 2013 GEIS discusses the impact of population increases on offsite dose and economic consequences. The 2013 GEIS, in section E.3.9.2, states the following:

> The 1996 GEIS estimated impacts at the mid-year of each plant's license renewal period (i.e., 2030 to 2050). To adjust the impacts estimated in the NUREGs and NUREG/CRs to the mid-year of the assessed plant's license renewal period, the information (i.e., exposure indexes [EIs]) in the 1996 GEIS can be used. The Els adjust a plant's airborne and economic impacts from the year 2000 to its mid-year license renewal period based on population increases. These adjustments result in anywhere from a 5 to a 30 percent increase in impacts, depending upon the plant being assessed. Given the range of uncertainty in these types of analyses, a 5 to 30 percent change is not considered significant. Therefore, the effect of increased population around the plant does not generally result in significant increases in impacts.

Table 3.11-2 of Turkey Point's ER provides population information for the "County Populations Totally or Partially Included within a 50-Mile Radius of Turkey Point." As Table 3.11-2 shows, FPL estimates that in 2053 (i.e., at the end of the license renewal period for unit 4) the population within the 50-mile radius will be 6,890,445. Assuming a uniform increase in population, the mid-year population (2043) is projected to be 6,366,881 persons (37 percent higher than the U.S. Census Bureau data for the four counties in 2010). FPL's estimated population increase is slightly above the 30 percent range determined by the NRC in the 2013 GEIS to be not significant. However, as discussed in section E.3.3 of the 2013 GEIS and this

SEIS, more recent estimates give significantly lower release frequencies and release fractions for the source term than was assumed in the 1996 GEIS. Specifically, the 2013 GEIS states that "a comparison of population dose from newer assessments illustrates a reduction in impact by a factor of 5 to 100 when compared to older assessments, and an additional factor of 2 to 4 due to the conservatism built into the 1996 GEIS values." Thus, the effect of this reduction in total dose from a radiological release following a severe accident far exceeds the effect of a population increase. The staff concludes that the effect of increased population around the plant does not result in significant increases in impacts. Thus, the staff concludes that no new and significant information exists for Turkey Point concerning population increase that would alter the conclusions reached in the 2013 GEIS or Turkey Point's previous SAMA analysis.

E.3.10 Summary/Conclusion (Section E.5 of the 2013 GEIS)

The 2013 GEIS categorizes "sources of new information" by their potential effect on the best-estimate environmental impacts associated with postulated severe accidents. These effects can (1) decrease the environmental impact associated with severe accidents, (2) not affect the environmental impact associated with severe accidents, or (3) increase the environmental impact associated with severe accidents.

Areas of new and significant information that can result in the first effect (decrease the environmental impacts associated with severe accidents) at Turkey Point include:

- New internal events information (significant decrease)
- New source term information (significant decrease)

Areas of new and significant information that can result in the second effect (no effect on the environmental impact associated with severe accidents) or the third effect (increase the environmental impact associated with severe accidents) include:

- Use of BEIR VII risk coefficients
- Consideration of external events (comparable to internal event impacts)
- Spent fuel pool accidents (could be comparable to full-power event impacts)
- Higher fuel burnup (small to moderate increases)
- Low power and reactor shutdown events (could be comparable to full-power event impacts)
- Population Increase

The 2013 GEIS states, "Given the difficulty in conducting a rigorous aggregation of these results with the differences in the information sources utilized, a fairly simple approach is taken. The GEIS estimated the net increase from the first five areas listed above would be (in a simplistic sense) approximately an increase by a factor of 4.7. At the same time, however, for Turkey Point, the reduction in risk due to newer internal event information is a decrease in risk by a factor of 23. The net effect of an increase by a factor of 4.7 and a decrease by a factor of 23 would be overall lower estimated impact (as compared to the 1996 GEIS assessment) by a factor of 18.3. Thus, the staff finds that there is no new and significant information related to the severe accidents at Turkey Point that would alter the conclusions reached in the 2013 GEIS or Turkey Point's previous SAMA analysis.

Other areas of new information relating to Turkey Point severe accident risk, severe accident environmental impact assessment, and cost-beneficial SAMAs are described below. These areas of new information demonstrate additional conservatism in the evaluations in the GEIS and FPL's ER, because they result in further reductions in the impact of a severe accident.

E.4 Other New Information Related to NRC Efforts to Reduce Severe Accident Risk Following Publication of the 1996 GEIS

The Commission has considered numerous ways to mitigate severe accidents, in addition to requiring a SAMA analysis at the time of initial license renewal, and has adopted various regulatory requirements for mitigating severe accident risks at reactor sites. In 1996, when it promulgated Table B-1 in Appendix B to Subpart A of 10 CFR Part 51, the Commission explained in a *Federal Register* notice:

> The Commission has considered containment improvements for all plants pursuant to its Containment Performance Improvement (CPI) program…and the Commission has additional ongoing regulatory programs whereby licensees search for individual plant vulnerabilities to severe accidents and consider cost beneficial improvements (Final rule, Environmental review for renewal of nuclear power plant operating licenses, 61 FR 28467 (June 5, 1996)).

These "additional ongoing regulatory programs" that the Commission mentioned include the IPE (individual plant examination) and the IPEEE (individual plant examination of external events) program, which consider "potential improvements to reduce the frequency or consequences of severe accidents on a plant-specific basis and essentially constitute a broad search for severe accident mitigation alternatives." Further, the Commission observed that the IPEs "resulted in a number of plant procedural or programmatic improvements and some plant modifications that will further reduce the risk of severe accidents." Based on these and other considerations, the Commission stated its belief that it is "unlikely that any site-specific consideration of SAMAs for license renewal will identify major plant design changes or modifications that will prove to be cost-beneficial for reducing severe accident frequency or consequences" (61 FR 28481). The Commission noted that it may review and possibly reclassify the issue of severe accident mitigation as a Category 1 issue upon the conclusion of its IPE/IPEEE program, but deemed it appropriate to consider severe accident mitigation alternatives for plants for which had not done so previously, pending further rulemaking on this issue (61 FR 28481).

The Commission reaffirmed its SAMA-related conclusions in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 and 10 CFR 51.53(c)(3)(ii)(L), in *Exelon Generation Co., LLC* (Limerick Generating Station, Units 1 and 2), CLI-13-07, (Oct. 31, 2013) (ADAMS Accession No. ML13304B417). In addition, the Commission observed that it had promulgated those regulations because it had "determined that one SAMA analysis would uncover most cost beneficial measures to mitigate both the risk and the effects of severe accidents, thus satisfying our obligations under NEPA" (NRC 2013d).

The NRC has continued to address severe accident-related issues since the agency published the GEIS in 1996. Combined NRC and licensee efforts have reduced risks from accidents beyond those that were considered in the 1996 GEIS. The 2013 GEIS describes many of those efforts (NRC 2013a). In some cases, such as the NRC's response to the accident at Fukushima, these activities are still ongoing. In the remainder of Section E.4 of this SEIS, the

NRC staff describes efforts to reduce severe accident risk (CDF and LERF) following publication of the GEIS in 1996. Each of these initiatives applies to all reactors, including Turkey Point Units 3 and 4. Section E.4.1 describes requirements adopted following the terrorist attacks in September 2001, to address the loss of large areas of a plant caused by fire or explosions. Section E.4.2 describes the SOARCA project, which indicates that source term timing and magnitude values may be significantly lower than source term values quantified in previous studies using other analysis methods. Section E.4.3 describes measures adopted following the Fukushima earthquake and tsunami events of 2013. Section E.4.4 discusses efforts that have been made to utilize plant operating experience to improve plant performance and design features. These are areas of new information that reinforce the conclusion that the probability-weighted consequences of a severe accident are SMALL for all plants, as stated in the 2013 GEIS, and further reduce the likelihood of finding a cost-beneficial SAMA that would substantially reduce the severe accident risk at Turkey Point.

E.4.1 10 CFR 50.54(hh)(2) Requirements Regarding Loss of Large Areas of the Plant Caused by Fire or Explosions

As discussed on page E-7 of the 2013 GEIS, following the terrorist attacks of September 11, 2001, the NRC conducted a comprehensive review of the agency's security program and made further enhancements to security at a wide range of NRC-regulated facilities. These enhancements included significant reinforcement of the defense capabilities for nuclear facilities, better control of sensitive information, enhancements in emergency preparedness, and implementation of mitigating strategies to deal with postulated events potentially causing loss of large areas of the plant due to explosions or fires, including those that an aircraft impact might create. For example, the Commission issued Order EA-02-026, "Interim Compensatory Measures (ICM) Order." The ICM Order provided interim safeguards and security compensatory measure, and ultimately led to the promulgation of a new regulation in 10 CFR 50.54(hh). This regulation requires commercial power reactor licensees to prepare for a loss of large areas of the facility due to large fires and explosions from any cause, including beyond-design-basis aircraft impacts. In accordance with 10 CFR 50.54(hh)(2), licensees must adopt mitigation guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities under circumstances associated with the loss of large areas of the plant due to explosion or fire.

NRC requirements pertaining to plant security are subject to NRC oversight on an ongoing basis under a plant's current operating license, and are beyond the scope of license renewal. As discussed in Section 5.3.3.1 of the 1996 GEIS, the NRC addresses security-related events using deterministic criteria in 10 CFR Part 73, "Physical Protection of Plants and Materials," rather than by risk assessments or SAMAs. However, the implementation of measures that reduce the risk of severe accidents, including measures adopted to comply with 10 CFR 50.54(hh), also have a beneficial impact on the level of risk evaluated in a SAMA analysis, the purpose of which is to identify potentially cost-beneficial design alternatives, procedural modifications, or training activities that may further reduce the risks of severe accidents. Inasmuch as FPL has updated Turkey Point's guidelines, strategies, and procedures to meet the requirements of 10 CFR 50.54(hh), those efforts have contributed to mitigation of the risk of a beyond design basis event. Accordingly, actions taken by FPL to comply with those regulatory requirements have further contributed to the reduction of risk at Turkey Point.

In sum, the new information regarding actions taken by FPL to prepare for potential loss of large areas of the plant due to fire or explosions has further contributed to the reduction of severe accident risk at Turkey Point. Thus, this information does not alter the conclusions reached in the 2013 GEIS regarding the consequences of a severe accident or Turkey Point's previous SAMA analysis.

E.4.2 SOARCA

The 2013 GEIS notes that a significant NRC effort is ongoing to re-quantify realistic severe accident source terms under the State-of-the-Art Reactor Consequence Analysis (SOARCA) project. Preliminary results indicate that source term timing and magnitude values quantified using SOARCA may be significantly lower than source term values quantified in previous studies using other analysis methods (NRC 2008). The NRC staff plans to incorporate this new information regarding source term timing and magnitude using SOARCA in future revisions of the GEIS.

The NRC has completed a SOARCA study for Surry Nuclear Power Station. The Surry Nuclear Power Station is a Westinghouse 3-loop PWR similar to Turkey Point. The Surry SOARCA summary concludes that with SOARCA, the NRC has achieved its objective of developing a body of knowledge regarding detailed, integrated, state-of-the-art modeling of the more important severe accident scenarios for Surry. SOARCA analyses indicate that successful implementation of existing mitigation measures can prevent reactor core damage or delay or reduce offsite releases of radioactive material. All SOARCA scenarios, even when unmitigated, progress more slowly and release much less radioactive material than the potential releases cited in the 1982 Siting Study (NUREG/CR–2239, "Technical Guidance for Siting Criteria Development"). As a result, the calculated risks of public health consequences of severe accidents modeled in SOARCA are very small.

This new information regarding the SOARCA project's findings has further contributed to the reduction of the calculated severe accident risk at Turkey Point, as compared to the 1996 GEIS and the Turkey Point SAMA evaluation for the initial license renewal application in 2000. Thus, the NRC staff finds there is no new and significant information related to Turkey Point SAMAs that would alter the conclusions reached in the 2013 GEIS or Turkey Point's previous SAMA analysis.

E.4.3 Fukushima-Related Activities

As discussed in Section E.2.1 of the 2013 GEIS, on March 11, 2011, a massive earthquake off the east coast of the main island of Honshu, Japan, produced a tsunami that struck the coastal town of Okuma in Fukushima Prefecture. This event damaged the six-unit Fukushima Dai-ichi nuclear power plant, causing the failure of safety systems needed to maintain cooling water flow to the reactors. Because of the loss of cooling, the fuel overheated, and there was a partial meltdown of fuel in three of the reactors. Damage to the systems and structures containing reactor fuel resulted in the release of radioactive material to the surrounding environment (NRC 2013a).

As further discussed in Section E.2.1 of the 2013 GEIS, in response to the earthquake, tsunami, and resulting reactor accidents at Fukushima Dai-ichi (hereafter referred to as the Fukushima events), the Commission directed the NRC staff to convene an agency task force of senior leaders and experts to conduct a methodical and systematic review of NRC regulatory requirements, programs, and processes (and their implementation) relevant to the Fukushima event. After thorough evaluation, the NRC required significant enhancements to U.S. commercial nuclear power plants. The enhancements included: adding capabilities to maintain key plant safety functions following a large-scale natural disaster; updating evaluations on the potential impact from seismic and flooding events; adding new equipment to better handle potential reactor core damage events; and strengthening emergency preparedness capabilities. Further information regarding this matter is presented in the 2013 GEIS and the NRC's Web site Fukushima-related actions at https://www.nrc.gov/reactors/operating/ops-experience/post-fukushima-safety-enhancements.html.

In sum, the Commission has imposed additional safety requirements on operating reactors following the Fukushima accident (as described in the preceding paragraphs). The new regulatory requirements contribute to the mitigation of the risk of a severe accident. Therefore, the NRC staff concludes there is no new and significant information related to the Fukushima events that would alter the conclusions reached in the 2013 GEIS or Turkey Point's previous SAMA analysis.

E.4.4 Operating Experience

Section E.2 of the 2013 GEIS mentions the considerable operating experience that supports the safety of U.S. nuclear power plants. As with the use of any technology, greater user experience generally leads to improved performance and, if applicable, improved safety. This additional experience has contributed to improved plant performance (e.g., as measured by trends in plant-specific performance indicators), a reduction in adverse operating events, and lessons learned that improve the safety of all the operating nuclear power plants. The items above contribute to improved safety as do those safety improvements not related to license renewal such as generic safety issues (e.g., Generic Safety Issue 191, "Assessment of Debris Accumulation on PWR Sump Pump Performance"). Thus, the performance and safety record of nuclear power plants operating in the United States, including Turkey Point, continue to improve. This is also confirmed by analysis which indicates that, in many cases, improved plant performance and design features have resulted in reductions in initiating event frequency, CDF, and containment failure frequency (NRC 2013a).

Conclusion

As discussed above, the NRC and the nuclear industry have addressed and continue to address numerous severe accident-related issues since the publication of the 1996 GEIS and the 2000 Turkey Point SAMA analysis. These actions reinforce the conclusion that the probability-weighted consequences of a severe accident are SMALL for all plants, as stated in the 2013 GEIS, and further reduce the likelihood of finding a cost-beneficial SAMA that would substantially reduce the severe accident risk at Turkey Point.

E.5 Florida Power & Light's Evaluation of New and Significant Information Pertaining to SAMAs, Using NEI 17-04, "Model SLR New and Significant Assessment Approach for SAMA"

In its evaluation of the significance of new information, the NRC staff considers that new information is significant if it provides a seriously different picture of the impacts of the Federal action under consideration. Thus, for mitigation alternatives such as SAMAs, new information is significant if it indicates that a mitigation alternative would substantially reduce an impact of the Federal action on the environment. Consequently, with respect to SAMAs, new information may be significant if it indicates a given potentially cost-beneficial SAMA would substantially reduce the impacts of a severe accident or the probability or consequences (risk) of a severe accident occurring.

As discussed in Section E.2.2 above, FPL stated in its environmental report submitted as part of its subsequent license renewal application, that it used the methodology in NEI 17-04, "Model SLR New and Significant Assessment Approach for SAMA," dated June 29, 2017 (NEI 2017) to evaluate new and significant information as it relates to the Turkey Point subsequent license renewal SAMAs. By letter dated January 31, 2018, the staff reviewed NEI 17-04 and found it acceptable for interim use, pending formal NRC endorsement of NEI 17-04 by incorporation in Regulatory Guide 4.2, Supplement 1, "Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications," (NRC 2018m). In general, as discussed above, the NEI 17-04 methodology (NEI 2017) does not consider a potential SAMA to be significant unless it reduces by at least 50 percent the maximum benefit as defined in Section 4.5, "Total Cost of Severe Accident Risk/Maximum Benefit," of NEI 05-01, Revision A, "Severe Accident Mitigation Alternatives (SAMA) Analysis Guidance Document."

NEI 17-04, "Model SLR New and Significant Assessment Approach for SAMA," describes a three-stage process for determining whether there is any "new and significant" information relevant to a previous SAMA analysis.

- **Stage 1**: The subsequent license renewal applicant uses PRA risk insights and/or risk model quantifications to estimate the percent reduction in the maximum benefit associated with (1) all unimplemented "Phase 2" SAMAs for the analyzed plant and (2) those SAMAs identified as potentially cost beneficial for other U.S. nuclear power plants and which are applicable to the analyzed plant. If one or more of those SAMAs are shown to reduce the maximum benefit by 50 percent or more, then the applicant must complete Stage 2. (Applicants that are able to demonstrate through the Stage 1 screening process that there is no potentially significant new information are not required to perform the Stage 2 or Stage 3 assessments).
- **Stage 2**: The subsequent license renewal applicant develops updated averted cost-risk estimates for implementing those SAMAs. If the Stage 2 assessment confirms that one or more SAMAs reduce the maximum benefit by 50 percent or more, then the applicant must complete Stage 3.
- **Stage 3**: The subsequent license renewal applicant performs a cost-benefit analysis for the "potentially significant" SAMAs identified in Stage 2.

The following sections describe FPL's application of the NEI 17-04 methodology to Turkey Point SAMAs. FPL determined that none of the SAMAs evaluated in Stage 1 reduced the maximum benefit by 50 percent or more. As a result, FPL concluded it is not required to perform the Stage 2 or Stage 3 evaluations for any SAMAs.

E.5.1 Data Collection

NEI 17-04 Section 3.1, "Data Collection," explains that the initial step of the assessment process is to identify the "new information" relevant to the SAMA analysis and to collect and develop those elements of information that will be used to support the assessment. The guidance document states that each applicant should collect, develop, and document the information elements corresponding to the stage or stages of the SAMA analysis performed for the site. For Turkey Point subsequent license renewal, the NRC staff reviewed the onsite information during an audit at NRC headquarters and determined that FPL had considered the appropriate information (NRC 2018d).

E.5.2 Stage 1 Assessment

Section 4.15.3, "Methodology for Evaluation of New and Significant SAMAs," of FPL's environmental report describes the process it used for identifying any potentially new and significant SAMAs from the 2000 SAMA analysis (FPL 2018f). In Stage 1 of the process, FPL used PRA risk insights and/or risk model quantifications to estimate the percent reduction in the maximum benefit associated with the following two types of SAMAs:

1) all unimplemented "Phase 2" SAMAs for Turkey Point
2) those SAMAs identified as potentially cost beneficial for other U.S. nuclear power plants and which are applicable to Turkey Point (FPL 2018f)

As discussed below, as a result of FPL's qualitative and quantitative Stage 1 screening, all potential SAMAs were found to reduce the maximum benefit by less than 50 percent, and they were therefore screened out from further evaluation. Therefore, Stage 2 of the NEI methodology was not entered, and an update of the Turkey Point Level 3 PRA was not needed.

E.5.3 Florida Power & Light's Evaluation of Unimplemented "Phase 2" SAMAs for Turkey Point

In 2000, FPL submitted an application for initial operating license renewal (FPL 2000), which the NRC approved in 2002. As part of that initial license renewal process, FPL performed a detailed evaluation of potential SAMAs, identifying 167 potential SAMAs. FPL then qualitatively screened out 93 of these potential SAMAs from further evaluation (for example, by screening out SAMAs that are only applicable to boiling water reactors), leaving 76 potential SAMAs. For these 76 SAMAs, FPL performed a detailed cost-benefit analysis (FPL 2000). The cost benefit analysis included development of a Level 3 probabilistic risk assessment (PRA) for Turkey Point Unit 3, which FPL used to calculate conditional offsite population doses and offsite economic consequences for each of the PRA source term categories (STCs). FPL developed the analysis for Turkey Point Unit 3, but it was applicable to the license renewal for both units (FPL 2000). By calculating the reduction in source term category frequencies for each potential SAMA, the present value dollar benefit of each SAMA was determined using the guidance of NUREG/BR-0184, "Regulatory Analysis Technical Evaluation Handbook," (FPL 2000). FPL then compared the benefit to a cost estimate for each to complete the cost-benefit comparison. The conclusion reached by FPL in the SAMA analysis in its 2000 environmental report and by the NRC staff in its 2002 SEIS was that none of the analyzed Turkey Point SAMAs were potentially cost-beneficial.

As part of its subsequent license renewal application, FPL examined the Turkey Point probabilistic risk assessment again, for insights. The purpose was to determine if there was any new and significant information regarding the SAMA analyses that were performed to support issuance of the initial renewed operating licenses for Turkey Point. FPL re-evaluated the 76 SAMAs that were considered in connection with initial license renewal, using the NEI 17-04 process. Based on the Phase 1 qualitative and quantitative screening results, FPL found that all plant-specific and industry SAMAs were demonstrated to not be new and significant. Therefore, FPL concluded that there is no new and significant information that would alter the conclusions of Turkey Point's SAMA analysis for initial license renewal.

E.5.4 Florida Power & Light Evaluation of SAMAs Identified as Potentially Cost Beneficial at Other U.S. Nuclear Power Plants and Which Are Applicable to Turkey Point

The 2013 GEIS (NRC 2013a) considered the plant-specific supplemental EISs that document potential environmental impacts and mitigation measures for severe accidents relevant to license renewal for each plant. Some of these plant-specific supplements had identified potentially cost-beneficial SAMAs. FPL reviewed the SEISs of plants with a similar design to Turkey Point (large, dry PWR containment), to identify potentially cost-beneficial SAMAs. FPL qualitatively screened from further evaluation any SAMAs that were not applicable to Turkey Point, SAMAs that were already implemented at Turkey Point, and SAMAs that had excessive implementation costs. In this regard, FPL screened out SAMAs from further consideration if the initial license renewal review found that they reduced the Turkey Point maximum benefit by greater than 50 percent but were found not to be cost effective due to their high estimated costs of implementation. FPL grouped the remaining SAMAs based on similarities in mitigation equipment or risk reduction benefits. FPL then evaluated all the remaining SAMAs for the impact they would have assuming those SAMAs were implemented at Turkey Point.

Section 4.15.4.2 of FPL's subsequent license renewal environmental report provides the Turkey Point Stage 1 screening evaluation, using the methodology in NEI 17-04 "Model SLR New and Significant Assessment Approach for SAMA." FPL evaluated 76 Turkey Point-specific SAMAs and 263 potentially cost-beneficial SAMAs identified at similarly designed nuclear power plants (industry SAMAs). The SAMAs were related to both internal and external events. Qualitative screening resulted in elimination from further analysis of all external event SAMAs in the Turkey Point subsequent license renewal application, based on application of the screening criteria in section 3.2.1 of NEI 17-04. Qualitative screening of internal event SAMAs, along with binning of similar SAMAs, reduced the total number of SAMAs requiring further evaluation to 13. FPL binned the SAMAs in a manner that allowed bounding cases that completely addressed a plant risk contributor to be defined to estimate the maximum possible benefits for any of the grouped SAMAs. For example, all intersystem loss-of-coolant accident (ISLOCA)-related SAMAs could be represented by a single case in which all ISLOCA events are set to zero (i.e., the risk of an ISLOCA event was assumed to be completely eliminated by SAMA implementation). The NRC staff finds that this bounding approach provides a conservative analysis.

Table 4.15-1 of FPL's environmental report lists the 13 SAMAs identified by FPL as requiring a quantitative screening analysis, including the industry internal events SAMAs and the Turkey Point-specific SAMAs. FPL then performed quantitative screening using the full internal events Turkey Point Level 2 probabilistic risk assessment and the CDF/LERF portions of the fire and flood probabilistic risk assessments. Specifically, FPL quantitatively screened SAMAs if the bounding Turkey Point-specific case yielded a reduction of less than 50 percent in the frequency of each source term category group. As stated in Section 4.15.4.1 of the environmental report, the criterion for quantitative screening from further evaluation in the Stage 1 evaluation was that the SAMA does not reduce any source term category group frequency by at least 50 percent; if a SAMA was found to reduce at least one source term category group frequency by at least 50 percent, the SAMA would be evaluated in a Stage 2 assessment (as described in section E.5). In accordance with this approach, FPL performed the qualitative and quantitative Stage 1 screening, and determined that all potential SAMAs were screened out from further evaluation.

Since none of the SAMAs were found to reduce the maximum benefit by at least 50 percent, FPL determined that the SAMAs are not "potentially significant" and a Stage 2 assessment is not needed. Therefore, FPL concluded it was not required to proceed to a Stage 2 assessment for any SAMAs. As stated in NEI 17-04, "if a plant is able to demonstrate that none of the SAMAs evaluated in the Stage 1 assessment are potentially significant, then the Stage 2 inputs, such as the projected population within a 50-mile radius of the plant, should be listed as "new information", but no work to estimate the actual 50-mile population is required." Accordingly, consistent with NEI 17-04, there was no need for FPL to conduct a quantitative assessment of the effect of an increase in population numbers relative to the population considered in its initial license renewal SAMA analysis

The NRC staff reviewed Turkey Point's onsite information and its SAMA identification and screening process, during an in-office audit at NRC headquarters (NRC 2018d). The staff found that FPL had used a methodical and reasonable approach to identify any SAMAs that might reduce the maximum benefit by at least 50 percent and therefore be considered to be potentially significant. Therefore, the NRC staff finds that FPL properly concluded, in accordance with the NEI 17-04 guidance, that a Stage 2 assessment was not needed.

E.5.5 Other New information

As discussed in FPL's subsequent license renewal application environmental report and in NEI 17-04, there are some inputs to the SAMA analysis that are expected to change or to potentially change for all plants. These inputs include the following:

- Updated Level 3 PRA model consequence results, which may be impacted by multiple inputs, including, but not limited to, the following:
    - population, as projected within a 50-mile (80-km) radius of the plant
    - value of farm and nonfarm wealth
    - core inventory (e.g., due to power uprate)
    - evacuation timing and speed
    - Level 3 PRA methodology updates
    - cost-benefit methodology updates

In addition, other changes that could be considered to be new information may be dependent on plant activities or site-specific changes. These types of changes (listed in NEI 17-04) include the following:

- Identification of a new hazard (e.g., a fault that was not previously analyzed in the seismic analysis)
    - Updated plant risk model (e.g., a fire probabilistic risk assessment that replaces the individual plant examination of external events (IPEEE) analysis).
- Impacts of plant changes that are included in the plant risk models will be reflected in the model results and do not need to be assessed separately.
- Non-modeled modifications to the plant
    - Modifications determined to have no risk impact need not be included (e.g., replacement of the condenser vacuum pumps), unless they impact a specific input to SAMA (e.g., new low-pressure turbine in the power conversion system that results in a greater net electrical output)

Offsite consequence codes used in SAMA analyses consider plant-specific inputs as provided above. A detailed SAMA analysis would be able to analyze numerous plant-specific variables and the sensitivity of a SAMA analysis to these variables. However, inasmuch as a thorough

SAMA analysis was previously performed for Turkey Point's initial license renewal, a new SAMA analysis is not required by 51.53(c)(3)(ii)(L) and 10 CFR Part 51, Table B-1. Rather, as explained above, the licensee is required to consider new and significant information, i.e., new information that provides a seriously different picture of the consequences of the Federal action under consideration. With respect to SAMAs, new information may be significant if it indicated a SAMA would substantially reduce the probability or consequences of a severe accident.

The NEI methodology in NEI 17-04 uses "maximum benefit" to determine if SAMA-related information is new and significant. Maximum benefit (MB) is defined in Section 4.5 of NEI 05-01, Revision A, "Severe Accident Mitigation Alternatives (SAMA) Analysis Guidance Document," (NEI 2005), as the benefit a SAMA could achieve if it eliminated all risk. The total off-site dose and total economic impact are the baseline risk measures from which the maximum benefit is calculated. The NEI methodology in NEI 17-04 considers a SAMA to be potentially significant if it reduces the maximum benefit by at least 50 percent. The NRC staff finds the criterion of exceeding a 50-percent reduction in MB to be a reasonable significance threshold, because its correlates with the significance determination used in the ASME/ANS PRA standard, NUMARC 93-01, and NEI 00-04, all of which have been endorsed by the staff. It is also a reasonable quantification of the qualitative criterion for significance, which states that "new information is significant if it presents a seriously different picture of the impacts of the Federal action under consideration." Furthermore, it is consistent with the criterion that was accepted by the NRC staff in the Limerick Generating Station license renewal final SEIS.

In evaluating the guidance in NEI 17-04, the NRC staff found the 50-percent reduction approach described in NEI 17-04 to be reasonable because, with respect to SAMAs, the staff concluded that new information may be significant if it indicates a potentially cost-beneficial SAMA could substantially reduce the probability or consequences (risk) of a severe accident occurring. The implication of this statement is that "significance" is not solely related to whether a SAMA is cost beneficial (which may be affected by economic factors, increases in population, etc.), but depends also on a SAMA's potential to significantly reduce risk to the public.

E.5.6 Conclusion

As described above, FPL evaluated a total of 339 SAMAs for Turkey Point subsequent license renewal and did not find any SAMAs that would reduce the maximum benefit by 50 percent or more, and that further analysis was not required based on the guidance in NEI 17-04. The NRC staff reviewed FPL's evaluation and concludes that the methods used, and the results obtained, were reasonable. Based on Turkey Point's Phase 1 qualitative and quantitative screening results, FPL demonstrated that none of the plant-specific and industry SAMAs that it considered constitute new and significant information in that none changed the conclusion of Turkey Point's previous SAMA analysis. Further, the NRC staff has not identified any other new and significant information that would alter the conclusions reached in the previous SAMA analysis for Turkey Point. Therefore, the NRC staff finds no new and significant information that would alter the conclusions of the SAMA analysis performed for Turkey Point's initial license renewal.

The NRC staff reviewed FPL's new and significant information analysis for severe accidents and SAMAs at Turkey Point during the subsequent license renewal period and finds the analysis and the methods used to be reasonable. Given the low residual risk at Turkey Point, the substantial decrease in CDF at Turkey Point since the previous SAMA analysis, and the fact that no potentially cost-beneficial SAMAs were identified during the Turkey Point's initial license renewal review, the staff considers it unlikely that FPL would have found any potentially cost-beneficial SAMAs for subsequent license renewal. Further, FPL's implementation of actions to satisfy the NRC's orders and regulatory requirements regarding beyond-design-basis events after the 9/11 and Fukushima events, as well as the conservative assumptions used in earlier severe accident studies and SAMA analyses, also made it unlikely that FPL would have found any potentially significant cost-beneficial SAMAs during its subsequent license renewal review. For all of the reasons stated above, the NRC staff concludes that the conclusions reached by FPL in its subsequent license renewal environmental report regarding SAMAs are reasonable and that there is no new and significant information regarding any potentially cost-beneficial SAMA that would substantially reduce the risks of a severe accident at Turkey Point.

LBP-19-08

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:

E. Roy Hawkens, Chairman
Dr. Sue H. Abreu
Dr. Michael F. Kennedy

In the Matter of	Docket Nos. 50-250-SLR & 50-251-SLR
FLORIDA POWER & LIGHT COMPANY	ASLBP No. 18-957-01-SLR-BD01
(Turkey Point Nuclear Generating Units 3 and 4)	October 24, 2019

MEMORANDUM AND ORDER
(Denying Requests for Rule Waiver and Admission of Newly Proffered Contentions, and Terminating Proceeding)

This proceeding involves Florida Power & Light Company's (FPL's) subsequent license renewal application for Turkey Point Nuclear Generating Units 3 and 4, located near Homestead, Florida. As relevant here, in March 2019, this Licensing Board granted a hearing request from Friends of the Earth, Inc., Natural Resources Defense Council, Inc., and Miami Waterkeeper, Inc. (collectively, Joint Intervenors) and admitted two environmental contentions challenging FPL's environmental report (ER). See LBP-19-3, 89 NRC __ (2019). That same month, the NRC Staff issued the Draft Supplemental Environmental Impact Statement (DSEIS) for Turkey Point Units 3 and 4. Pursuant to the migration tenet, Joint Intervenors' two admitted contentions became challenges to the DSEIS.[1] In July 2019, this Board granted FPL's motions

[1] A contention "migrates" when a licensing board construes an admitted contention challenging an applicant's environmental review document (here, FPL's ER) as a challenge to a subsequently issued environmental review document prepared by the NRC Staff (here, the NRC Staff's DSEIS) without the petitioner amending the contention. See Crow Butte Res., Inc. (In Situ Leach Facility, Crawford, Neb.), CLI-15-17, 82 NRC 33, 42 n.58 (2015).

to dismiss Joint Intervenors' two admitted contentions as moot, having been cured by new information in the DSEIS. See LBP-19-6, 90 NRC __ (2019). Now pending before this Licensing Board are requests from Joint Intervenors seeking (1) a rule waiver; and (2) the admission of six newly proffered environmental contentions challenging the DSEIS.

For the reasons discussed below, we deny Joint Intervenors' requests. Because our ruling disposes of all pending contentions, this proceeding is terminated at the Licensing Board level.

I. PROCEDURAL BACKGROUND

On January 30, 2018, FPL applied for a twenty-year subsequent license renewal (SLR) for two nuclear power reactors, Turkey Point Units 3 and 4.[2] As required by 10 C.F.R. § 51.53(c), FPL submitted an ER with its application.[3] In response to a notice of opportunity to request a hearing published in the Federal Register,[4] Joint Intervenors filed a timely hearing request that raised challenges to the ER.[5]

On March 7, 2019, this Board granted Joint Intervenors' hearing request and admitted two environmental contentions of omission, Contentions 1-E and 5-E. See LBP-19-3, 89 NRC

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[2] See Letter from Mano K. Nazar, President and Chief Nuclear Officer, FPL, to Document Control Desk, NRC (Jan. 30, 2018); [FPL], Turkey Point Nuclear Plant Units 3 and 4 [SLR] Application (rev. 1 Apr. 2018) [hereinafter SLRA]. The original licenses issued to FPL for Units 3 and 4 authorized forty years of operation, and the first renewal was for an additional twenty years of operation. The current licenses for the units will expire, respectively, on July 19, 2032 and April 10, 2033. See SLRA at 1-1.

[3] See [FPL] SLRA, App. E, Applicant's [ER], Subsequent Operating License Renewal Stage, Turkey Point Nuclear Plant Units 3 and 4 (Jan. 2018) [hereinafter ER].

[4] See [FPL]; Turkey Point Nuclear Generating, Unit Nos. 3 and 4, 83 Fed. Reg. 19,304 (May 2, 2018); see also Commission Order (June 29, 2018) at 2 (unpublished) (granting a thirty-day filing extension).

[5] See LBP-19-3, 89 NRC at __ (slip op. at 3). Southern Alliance for Clean Energy (SACE) and Albert Gomez also filed hearing requests. See id. Additionally, Monroe County, Florida requested to participate as an interested governmental participant in support of the contentions proffered by SACE. See id. at 5.

at __ n.82 (slip op. at 63 n.82).[6] "A contention of omission is one that alleges an application suffers from an improper omission, whereas a contention of adequacy raises a specific substantive challenge to how particular information or issues have been discussed in the application." Fla. Power & Light Co. (Turkey Point Nuclear Generating Plant, Units 6 & 7), LBP-11-6, 73 NRC 149, 200 n.53 (2011); see also Pac. Gas & Elec. Co. (Diablo Canyon Nuclear Power Plant, Units 1 & 2), CLI-16-11, 83 NRC 524, 534 (2016).

In March 2019, the NRC Staff issued a DSEIS for Turkey Point Units 3 and 4 as required by 10 C.F.R. § 51.70.[7] Pursuant to the migration tenet, see supra note 1, Joint Intervenors' two contentions, which originally challenged FPL's ER, became challenges to the NRC Staff's DSEIS. On May 20, 2019, FPL moved to dismiss Contentions 1-E and 5-E as moot, arguing that the omissions had been cured by new information in the DSEIS. See LBP-19-6, 90 NRC at __ (slip op. at 3). On July 8, 2019, this Board granted FPL's request to dismiss Contentions 1-E and 5-E as moot. See id. at __ (slip op. at 10).

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[6] In the same decision, this Board (1) granted SACE's hearing request and admitted two proffered contentions; (2) granted Monroe County, Florida's request to participate as an interested governmental participant in support of SACE's two admitted contentions; and (3) denied Mr. Gomez's hearing request. See LBP-19-3, 89 NRC at __ (slip op. at 63).

On April 9, 2019, SACE withdrew from this proceeding as part of a settlement with FPL, resulting in the dismissal of its admitted contentions. See LBP-19-6, 90 NRC at __ (slip op. at 2). Monroe County, Florida thereby lost its status as an interested governmental participant in support of SACE's contentions. Cf. La. Energy Servs. (Nat'l Enrichment Facility), CLI-04-35, 60 NRC 619, 626–27 (2004) (affirming licensing board's ruling that a government entity could not participate as an interested governmental participant without adopting an admitted contention pursuant to 10 C.F.R. § 2.315(c)).

[7] See Office of Nuclear Reactor Regulation, NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supp. 5, Second Renewal, Regarding Subsequent License Renewal for Turkey Point Nuclear Generating Unit Nos. 3 & 4, Draft Report for Comment (Mar. 2019) (ADAMS Accession No. ML19078A330) [hereinafter DSEIS].

Meanwhile, pursuant to this Board's scheduling order governing the submission of new or amended contentions based on the DSEIS,[8] on June 24, 2019, Joint Intervenors moved to admit six newly proffered environmental contentions of adequacy challenging the DSEIS.[9] Joint Intervenors also submitted a petition for waiver of 10 C.F.R. §§ 51.53(c)(3), 51.71(d), and 10 C.F.R. Part 51, Subpart A, Appendix B.[10] The NRC Staff and FPL opposed the motion and the petition for waiver.[11] Joint Intervenors filed a reply in support of their motion.[12]

On September 9, 2019, this Board held an oral argument at NRC headquarters in Rockville, Maryland, to assess Joint Intervenors' rule waiver request and the admissibility of

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8 See Licensing Board Order (Granting in Part Intervenors' Joint Motion for Partial Reconsideration of Initial Scheduling Order) (Apr. 2, 2019) (unpublished) [hereinafter April 2019 Scheduling Order].

9 See [Joint Intervenors'] Motion to Migrate Contentions & Admit New Contentions in Response to NRC Staff's [DSEIS] (June 24, 2019). Joint Intervenors later filed an amended motion. See [Joint Intervenors'] Amended Motion to Migrate Contentions & Admit New Contentions in Response to NRC Staff's [DSEIS] (June 28, 2019) [hereinafter Joint Intervenors' Motion for New Contentions]. This Board's decision in LBP-19-6 rendered moot that portion of Joint Intervenors' motion that sought to migrate Contentions 1-E and 5-E as originally admitted.

10 See [Joint Intervenors'] Petition for Waiver of 10 C.F.R. §§ 51.53(c)(3), 51.71(d), and 10 C.F.R. Part 51, Subpart A, Appendix B (June 24, 2019) [hereinafter Joint Intervenors' Petition for Waiver].

11 See NRC Staff's Answer to Joint Intervenors' (1) Amended Motion to Migrate or Amend Contentions 1-E and 5-E and to Admit Four New Contentions, and (2) Petition for Waiver (July 19, 2019) [hereinafter NRC Staff's Answer]; [FPL's] Answer Opposing Intervenors' Motion to Migrate or Amend Contentions 1-E and 5-E and to Admit New Contentions 6-E, 7-E, 8-E, and 9-E (July 19, 2019) [hereinafter FPL's Answer to Contentions]; [FPL's] Answer to Intervenors' Petition for Waiver of Certain 10 C.F.R. Part 51 Regulations (July 19, 2019) [hereinafter FPL's Answer to Waiver Petition].

12 See Reply in Support of Motion to Migrate Contentions & Admit New Contentions in Response to NRC Staff's [DSEIS] (July 26, 2019) [hereinafter Joint Intervenors' Reply].

On July 26, 2019, Joint Intervenors also filed a reply in support of their petition for waiver, which FPL moved to strike, arguing that 10 C.F.R. § 2.335 does not permit a litigant who petitions for waiver to file a reply. We granted FPL's motion. See Licensing Board Order (Granting FPL's Motion to Strike) (Aug. 20, 2019) (unpublished).

their newly proffered contentions. See Official Transcript of Proceedings, [FPL] Turkey Point Nuclear Generating Units 3 and 4 at 260–466 (Sept. 9, 2019) [hereinafter Tr.].

II. LEGAL STANDARDS

We summarize below three legal standards that are implicated in this case: (1) the three-factor good cause standard in 10 C.F.R. § 2.309(c) governing the timeliness of contentions that are proffered after the deadline for submitting initial hearing petitions in 10 C.F.R. § 2.309(b); (2) the six-factor contention admissibility standard in 10 C.F.R. § 2.309(f)(1); and (3) the rule waiver criteria in 10 C.F.R. § 2.335 for a litigant who seeks to challenge a Commission regulation.

A. THE GOOD CAUSE STANDARD IN 10 C.F.R. § 2.309(c)

A litigant who, like Joint Intervenors, proffers new or amended contentions after the deadline in 10 C.F.R. § 2.309(b) must demonstrate good cause for the belated filing. See 10 C.F.R. § 2.309(c)(1). Good cause exists if the litigant shows that (1) the information upon which the new or amended contention is based was not previously available; (2) the information upon which the contention is based is materially different from information previously available;[13] and (3) the contention has been submitted in a timely fashion based on the availability of the subsequent information.[14] See id. § 2.309(c)(1)(i)–(iii). Regarding the timeliness criterion in item 3, this Board's Scheduling Order, see supra note 8, established June

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[13] The term "materially" within the meaning of section 2.309(c)(1)(ii) "describes the type or degree of difference between the new information and previously available information . . ., and it is synonymous with, for example, 'significantly,' 'considerably,' or 'importantly.'" Fla. Power & Light Co. (Turkey Point Units 6 & 7), LBP-17-6, 86 NRC 37, 48, aff'd on other grounds, CLI-17-12, 86 NRC 215 (2017).

[14] Cf. Entergy Nuclear Vermont Yankee LLC and Entergy Nuclear Operations, Inc. (Vermont Yankee Nuclear Power Station), CLI-11-2, 73 NRC 333, 342 n.43 (2011) ("We and our Licensing Boards generally consider approximately 30–60 days as the limit for timely filings based on new information.").

24, 2019 as the deadline for filing new or amended contentions based on the DSEIS. See April 2019 Scheduling Order at 3.

B. THE CONTENTION ADMISSIBILITY STANDARD IN 10 C.F.R. § 2.309(f)(1)

To be admissible, a timely-filed contention must satisfy the following six-factor contention admissibility criteria in 10 C.F.R. § 2.309(f)(1):

> (i) Provide a specific statement of the issue of law or fact to be raised or controverted . . .;
>
> (ii) Provide a brief explanation of the basis for the contention;
>
> (iii) Demonstrate that the issue raised in the contention is within the scope of the proceeding;
>
> (iv) Demonstrate that the issue raised in the contention is material to the findings the NRC must make to support the action that is involved in the proceeding;
>
> (v) Provide a concise statement of the alleged facts or expert opinions which support the requestor's/petitioner's position on the issue . . ., together with references to the specific sources and documents on which the requestor/petitioner intends to rely to support its position on the issue; [and]
>
> (vi) . . . [P]rovide sufficient information to show that a genuine dispute exists with the applicant/licensee on a material issue of law or fact. This information must include references to specific portions of the application . . . that the petitioner disputes and the supporting reasons for each dispute.

10 C.F.R. § 2.309(f)(1)(i)–(vi).

The Commission's contention admissibility standard is "strict by design," AmerGen Energy Co. (Oyster Creek Nuclear Generation Station), CLI-06-24, 64 NRC 111, 118 (2006) (quoting Dominion Nuclear Conn., Inc. (Millstone Nuclear Power Station, Units 2 & 3), CLI-01-24, 54 NRC 349, 358 (2001)), and failure to comply with any admissibility requirement "renders a contention inadmissible." Entergy Nuclear Operations, Inc. (Indian Point, Unit 2), CLI-16-5, 83 NRC 131, 136 (2016).

C. THE RULE WAIVER CRITERIA IN 10 C.F.R. § 2.335

Pursuant to section 2.335(a), "no rule or regulation of the Commission . . . is subject to attack by way of [any] . . . means in any adjudicatory proceeding subject to [10 C.F.R. Part 2]." 10 C.F.R. § 2.335(a). The same regulation recognizes, however, that "special circumstances" may exist in a particular proceeding "such that the application of the rule or regulation (or a provision of it) would not serve the purposes for which the rule or regulation was adopted." Id. § 2.335(b). In such circumstances, a litigant may petition that the application of a specified Commission rule or regulation "be waived or an exception be made for the particular proceeding." Id.

Commission precedent construing section 2.335(b) provides that a litigant's petition for rule waiver must be accompanied by an affidavit demonstrating that the following four factors (commonly referred to as the Millstone factors) are satisfied:

(i) the rule's strict application would not serve the purposes for which it was adopted;

(ii) the movant has alleged special circumstances that were not considered, either explicitly or by necessary implication, in the rulemaking proceeding leading to the rule sought to be waived;

(iii) those circumstances are unique to the facility rather than common to a large class of facilities; and

(iv) a waiver of the regulation is necessary to reach a significant safety [or environmental] problem.

Dominion Nuclear Conn., Inc. (Millstone Nuclear Power Station, Units 2 & 3), CLI-05-24, 62 NRC 551, 559–60 (2005) (internal quotations omitted); see Exelon Generation Co. (Limerick Generating Station, Units 1 & 2), CLI-13-7, 78 NRC 199, 209 (2013) (holding that the fourth Millstone factor applies to a significant environmental problem). If a licensing board concludes that the petitioning litigant has made a prima facie showing that section 2.335(b) is satisfied, the board shall, "before ruling on the petition, certify the matter directly to the Commission" for a determination as to whether the rule should be waived or an exception made. 10 C.F.R. § 2.335(d).

The Commission has described the rule waiver standard as "stringent by design." Limerick, CLI-13-7, 78 NRC at 207. "[T]o challenge the generic application of a rule, a petitioner seeking waiver must show that there is something extraordinary about the subject matter of the proceeding such that the rule should not apply." Id.

III. ANALYSIS

A. CONTENTION 1-Eb IS NOT ADMISSIBLE

In Contention 1-Eb, Joint Intervenors allege that "[t]he DSEIS fails to analyze adequately mechanical draft cooling towers as a reasonable alternative that could mitigate adverse impacts of the cooling canal system [(CCS)] in connection with the license renewal of Turkey Point Units 3 and 4." Joint Intervenors' Motion for New Contentions at 8.[15] Specifically, Joint Intervenors assert that the DSEIS fails adequately to "consider how the cooling tower alternative could reduce acknowledged adverse impacts to (1) threatened, endangered, and protected species and essential fish habitat and (2) groundwater use conflicts." Id. at 12.

The NRC Staff and FPL argue that both components of Contention 1-Eb are inadmissible pursuant to 10 C.F.R. § 2.309(f)(1). See NRC Staff's Answer at 19–23; FPL's Answer to Contentions at 10–20.[16] We agree.

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[15] As discussed supra Part I, this Board admitted Contention 1-E as a contention of omission, but we subsequently dismissed it as moot based on curative information in the DSEIS. See LBP-19-6, 90 NRC at __, __ (slip op. at 1, 10). Contention 1-Eb is an amended version of Contention 1-E that challenges the adequacy of the curative information.

[16] FPL also argues that Contention 1-Eb fails to satisfy the good cause standard in section 2.309(c) for belated filings to the extent it alleges that the DSEIS's cooling tower alternative discussion failed adequately to consider groundwater use conflicts. See FPL Answer to Contentions at 9–10. FPL is incorrect. The DSEIS contains a cooling tower alternative analysis (which includes a groundwater use conflicts discussion) that FPL failed to include in the ER. See Joint Intervenors' Motion for New Contentions at 9; LBP-19-6, 90 NRC at __–__ (slip op. at 4–7). Contention 1-Eb's challenge is thus directed at new information that (1) was not previously available; and (2) is materially different from previously available information in the

1. Regarding the first component of Contention 1-Eb, Joint Intervenors fail to establish a genuine issue of material law or fact in asserting that the DSEIS fails to consider how the cooling tower alternative could mitigate adverse impacts to threatened, endangered, and protected species and essential fish habitat. See Joint Intervenors' Motion for New Contentions at 12.[17] The DSEIS describes the scenario in which discontinued use of the CCS as a heat sink for Units 3 and 4 (a consequence of the cooling tower alternative) would result in less heat being discharged to the CCS, which could cause the water in the CCS to become "less saline and create more favorable habitat for [Endangered Species Act (ESA)-listed] species." DSEIS at 4-68.[18] The DSEIS further explains that if the CCS were no longer used to

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ER, thereby satisfying section 2.309(c)(1)(i) and (ii). Additionally, Joint Intervenors submitted Contention 1-Eb within the June 24, 2019 deadline established by this Board's April 2019 Scheduling Order, thereby satisfying the timeliness requirement in section 2.309(c)(1)(iii). The good cause standard, see supra Part II.A, is satisfied.

[17] Joint Intervenors are similarly incorrect in asserting broadly that the DSEIS "is devoid of any substance on the environmental benefits" of the cooling tower alternative. Joint Intervenors' Motion for New Contentions at 11. See, e.g., DSEIS § 4.5.7.1 (concluding that the impact of the cooling tower alternative on surface water resources would be "SMALL"); id. § 4.5.7.2 (concluding that the impact of the cooling tower alternative on groundwater resources would be "SMALL"); id. § 4.6.7 (concluding that the impact of the cooling tower alternative on terrestrial resources would be "less intense" than the impacts common to all replacement power alternatives due to "the smaller land area required for construction and operation," but the impacts would nevertheless be "MODERATE" due to impacts from the "permanent disturbance, fragmentation, and degradation of important terrestrial habitats"); id. § 4.7.7 (concluding that the impact of the cooling tower alternative on aquatic resources would be "MODERATE" in the local environs of the plant because cooling tower construction "would result in the permanent loss or impairment of sensitive aquatic habitats and could affect ecosystem function and connectivity"; however, FPL's restoration activities pursuant to its nutrient management plan "would likely return portions of the CCS to a seagrass-based ecological system"); id. at 2-22 (summarizing in Table 2-2 the environmental impacts of the cooling tower alternative).

[18] Joint Intervenors correctly observe that some of the NRC Staff's arguments regarding the environmental benefits of discontinued use of the CCS as a heat sink for Units 3 and 4 rely on discussions from the DSEIS section on the "no-action alternative" rather than the DSEIS section on the "cooling tower alternative." See, e.g., Tr. at 315. Joint Intervenors are incorrect, however, in asserting that such reliance is improper unless the DSEIS expressly states that an analysis or conclusion in one section also applies to another section. See id. at 317. Nothing in the National Environmental Policy Act (NEPA) proscribes an agency from arguing that an analysis or conclusion in one section of the DSEIS also applies to other sections where, as here, see id. at 320, 327–28, a sensible reading of the DSEIS supports such an argument. Cf.

cool Units 3 and 4, FPL would still be required to take the CCS restorative actions mandated by a 2016 Consent Order with the State of Florida[19] and a 2015 Consent Agreement with Miami-Dade County,[20] see id., which compel FPL to, inter alia, decrease the salinity of the CCS, develop a nutrient management plan for the CCS, and restore seagrass within portions of the CCS.[21] The DSEIS concludes that, under these circumstances, "the CCS would likely continue to provide habitat for ESA-listed species." Id. The DSEIS also states that as a result of continuing restoration activities during cooling tower operations, portions of the CCS would likely be restored "to a seagrass-based ecological system." Id. at 4-60. Finally, the DSEIS contains the following discussion regarding special status species and habitats for the cooling tower alternative:

> To the extent that license amendments would be necessary to authorize cooling towers to dissipate excess heat during plant operation, . . . the Endangered Species Act and Magnuson-Stevens Act would require the NRC to consult with the U.S. Fish and Wildlife Service and National Marine Fisheries Service, as applicable, during the [S]taff's review of that alternative. If the cooling water system alternative required a Clean Water Act, Section 404 permit, the U.S. Army Corps of Engineers could be involved in [Endangered Species Act] consultation. The consultations would determine whether the construction and operation of cooling towers would affect any federally listed species, adversely modify or destroy designated critical habitat, or result in adverse effects on Essential Fish Habitat, if present. Ultimately, the magnitude and significance of adverse impacts on special status species and habitats would depend on the location and layout of the cooling towers, the design of the cooling towers, operational parameters, and the special status species and habitats present in the area when the alternative is implemented.

NRDC v. Morton, 458 F.2d 827, 834 (D.C. Cir. 1972) ("[I]t is the essence and thrust of NEPA that the pertinent [EIS] serve to gather in one place a discussion of the relative environmental impact of alternatives.").

[19] See Fla. Dep't of Envtl. Prot. v. FPL, OGC File No. 16-02441, Consent Order (June 20, 2016) (ADAMS Accession No. ML16216A216) [hereinafter Florida Consent Order].

[20] See Miami-Dade County, Dep't of Regulatory and Econ. Res., Division of Envtl. Res. Mgmt. v. FPL, Consent Agreement (Oct. 7, 2015) (ADAMS Accession No. ML15286A366) [hereinafter Miami-Dade Consent Agreement].

[21] See NRR, Biological Assessment for the Turkey Point Nuclear Generating Unit Nos. 3 and 4 Proposed [SLR] at 36 (Dec. 2018) (ADAMS Accession No. ML18353A835) (incorporated by reference in the DSEIS at 4-60) [hereinafter Biological Assessment].

Id. at 4-70.

Joint Intervenors fail to show why the above discussions are inadequate, and they fail to contest any of the above conclusions regarding the beneficial impacts on special species and habitat if the CCS were no longer used as a heat sink for Units 3 and 4. These failures render the first component of Contention 1-Eb inadmissible pursuant to 10 C.F.R. § 2.309(f)(1)(vi) for failing to show a genuine dispute with the DSEIS on a material issue of law or fact.

2. The second component of Contention 1-Eb fares no better. Joint Intervenors argue that the DSEIS fails to consider how the cooling tower alternative could mitigate adverse impacts to groundwater use conflicts. See Joint Intervenors' Motion for New Contentions at 12. More specifically, they claim that the DSEIS "does not analyze how ending the heat contribution of Turkey Point Units 3 and 4 to the cooling canals could freshen the water and reduce the groundwater impacts faster." Id. at 16. Joint Intervenors are incorrect.

The DSEIS describes the scenario in which discontinued use of the CCS would reduce discharges of heated water and other effluents to the CCS, potentially reducing the amount of water used to support freshening activities. See DSEIS at 4-35 to 4-36. Joint Intervenors do not cite, much less contest, that part of the DSEIS. This aspect of Contention 1-Eb is therefore inadmissible for failing to raise a genuine dispute with the DSEIS on a material issue of law or fact, as required by 10 C.F.R. § 2.309(f)(1)(vi).

B. CONTENTION 5-Eb IS NOT ADMISSIBLE

In Contention 5-Eb, Joint Intervenors assert that "[t]he DSEIS is deficient in its analysis of the potential impacts of ammonia releases during the renewal period on threatened and endangered species and their critical habitat." Joint Intervenors' Motion for New Contentions at 21.[22] Joint Intervenors specifically fault the DSEIS for "fail[ing] to consider the impacts of

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[22] As discussed supra Part I, this Board admitted Contention 5-E as a contention of omission, but we subsequently dismissed it as moot based on curative information in the

ammonia discharges on all but one threatened and endangered species [i.e., the West Indian manatee] and important habitat." Id. at 23–24.

The NRC Staff and FPL argue that Contention 5-Eb is inadmissible pursuant to 10 C.F.R. § 2.309(f)(1). See NRC Staff's Answer at 23–30; FPL's Answer to Contentions at 20–26.[23] We agree.

In the DSEIS and the Biological Assessment (which is incorporated by reference in the DSEIS, see supra note 21), the NRC Staff discusses the environment at the Turkey Point facility and the role that ammonia might play in that environment. For example, the DSEIS states that FPL monitors the CCS, Biscayne Bay, Card Sound, marshland, mangrove areas, and canals adjacent to the CCS "for numerous water quality parameters, including ammonia and other nutrients" to evaluate the effects, if any, of CCS operations on the surrounding environment. DSEIS at 3-41. Ammonia concentrations in the CCS, as measured between June 2010 and May 2016, ranged from below detectable levels to 0.3 milligrams per liter (mg/L), and they averaged 0.04 mg/L. Id. at 3-42. Notably, these measurements are all below the Miami-Dade County water quality standard for ammonia of 0.5 mg/L, and the average concentration is more than an order of magnitude below that standard. See id.[24]

DSEIS. See LBP-19-6, 90 NRC at __, __ (slip op. at 1, 10). Contention 5-Eb is an amended version of Contention 5-E that challenges the adequacy of the curative information.

[23] FPL also argues that Contention 5-Eb fails to satisfy the good cause standard in section 2.309(c). See FPL's Answer to Contentions at 7–8. FPL is incorrect. The DSEIS includes new information and new analysis regarding ammonia emanating from the CCS that FPL failed to include in the ER. See Joint Intervenors' Motion for New Contentions at 21–22; LBP-19-6, 90 NRC at __–__ (slip op. at 7–10). Contention 5-Eb's challenge to that new information and analysis is thus based on information that (1) was not previously available; and (2) is materially different from previously available information in the ER, thereby satisfying section 2.309(c)(1)(i) and (ii). Additionally, Joint Intervenors submitted Contention 5-Eb within the June 24, 2019 deadline established by this Board's April 2019 Scheduling Order, thereby satisfying the timeliness requirement in section 2.309(c)(1)(iii). The good cause standard, see supra Part II.A, is satisfied.

[24] The DSEIS attributes the existence of ammonia in the CCS to the decay of organic material. See DSEIS at 3-42. According to the DSEIS, ammonia is transported from the CCS

As explained in the DSEIS, absent species-specific information to the contrary, the NRC Staff "assumes that the relevant State water quality criteria [here, the Miami-Dade ammonia water quality standard] are reasonably protective of [threatened or endangered species] because under Section 303(c) of the Clean Water Act, the [Environmental Protection Agency (EPA)] or the States are required to adopt water quality standards to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." DSEIS at 4-66; accord Biological Assessment at 61 ("[I]f waters inhabited by [threatened or endangered species] meet water quality criteria for ammonia, the NRC [S]taff assumes that there would be no lethal effects or impairments to growth, survival, or reproduction [of such species].").

The DSEIS states that "no contaminants associated with the CCS, including ammonia, have been found in Biscayne Bay itself[.]" DSEIS at 4-66. The DSEIS further states that FPL's water "monitoring program has not detected evidence in the surrounding marsh and mangroves areas of any impacts of ammonia [or other nutrients] from the CCS on soil pore water quality via the groundwater pathway[.]" Id. at 3-53. Finally, the Biological Assessment states that based on data from FPL's "extensive water quality monitoring program," there is "no evidence of an ecological impact [from ammonia] on the areas surrounding the CCS and no discernible influence from the CCS on Biscayne Bay[.]" Biological Assessment at 60; accord DSEIS at 4-22 ("[D]iscern[i]ble effects from CCS . . . ammonia . . . on Biscayne Bay or Card Sound water qualities ha[ve] not been detected.").

Although no ammonia attributable to the CCS has been found in Biscayne Bay, see DSEIS at 4-65, and no effect from CCS ammonia has been detected in Biscayne Bay or Card Sound, see id. at 4-22, the DSEIS states that exceedances of the Miami-Dade ammonia water quality standard have been detected at the bottom of the Barge Turning Basin, the Turtle Point

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by the outflow of water into groundwater that then travels to adjacent surface water bodies. See id. at 3-43 to 3-44. As discussed infra in text, however, there is no evidence of an ecological impact on Biscayne Bay or Card Sound from the low levels of ammonia in the CCS.

remnant canal, the S-20 canal, and the Sea-Dade remnant canal, which are excavations outside of, but close to, the CCS. See DSEIS at 3-50 to 3-53; Biological Assessment at 60. A report referenced in the DSEIS concludes that these elevated ammonia levels appear to be "limited to the locations of deep stagnant anoxic [i.e., low oxygen] water bodies," and are "attributable to the degradation of plant and animal material." DSEIS at 3-51; accord id. ("[T]he [elevated] ammonia values are consistent with the anoxic conditions that exist at the bottom of remnant canals and the accumulation of organic matter falling into the remnant canals from surrounding areas of the bay.").

The NRC Staff analyzed the impact of the elevated ammonia levels in the deep basin and remnant canals on the following threatened or endangered species that might conceivably be exposed: four types of sea turtles; the smalltooth sawfish; and the West Indian manatee. See DSEIS at 4-62 to 4-67; Biological Assessment at 59–62. Regarding sea turtles, the NRC Staff stated that they are unlikely to be present in the "stagnant, or dead-end canals." DSEIS at 4-66. "Even if sea turtles were to be present in the canals, exposure time would be limited because sea turtles are expected to only occur transiently and for short durations, if at all." Id. The NRC Staff therefore concluded that "the very low likelihood of sea turtles to be exposed to elevated ammonia levels and the short duration of potential exposure is unlikely to result in measurable effects on sea turtles." Id.

Regarding smalltooth sawfish, the NRC Staff observed that they are a ureotelic species that "convert ammonia to urea and native tri-methyl amine oxide, which counteracts its toxicity" and, accordingly, they "are expected to be less vulnerable to ambient ammonia than many other aquatic species." DSEIS at 4-66. Based on this information, the NRC Staff concluded "that even if smalltooth sawfish are present in the canal areas with elevated ammonia levels, individuals are unlikely to be measurably affected." Id.

Finally, with regard to the West Indian manatee, the NRC Staff observed that the "stagnant or dead-end canals" where the elevated ammonia concentrations are located "do not provide preferred habitat for manatees[.]" Biological Assessment at 61. The NRC Staff concluded that "because of the very low likelihood of manatees [being] exposed to contaminants associated with the CCS, including ammonia, and because of the short duration of any such potential exposure, any effects on manatees would be insignificant or discountable." Id. Additionally, the NRC Staff concluded that "continued operation of Turkey Point Unit[s] . . . 3 and 4 will not appreciably diminish the ecological value of designated critical habitat within Biscayne Bay for the manatee[.]" Id.; accord id. at 62.

The NRC Staff also analyzed the impact of the CCS, including its ammonia content, on (1) ESA-listed species that inhabit the CCS, see Biologic Assessment at 32–37, 44, 45–47; DSEIS at 2-23 (Table 2-2, Note (a)); id. at 4-6 (Table 4-2, Note (c)); (2) ESA-listed species that may feed in the CCS, see Biological Assessment at 41–42, 49–55, 57–58; and (3) ESA-listed species in wetlands. See id. at 46–47, 51–53, 57–58, 64.[25]

As shown above, the NRC Staff analyzed the impact of ammonia on threatened and endangered species and sensitive habitats. The sole basis for Joint Intervenors' claim of inadequate analysis is their assertion that the DSEIS includes a more thorough analysis for the West Indian manatee than for other threatened and endangered species. See Joint Intervenors' Motion for New Contentions at 24–25. Contrary to Joint Intervenors' understanding, however, different analyses for different species based on different circumstances do not perforce equate to inadequate analyses. Rather, case law supports the conclusion that the NRC Staff acts reasonably—and, hence, consistent with NEPA—in analyzing the impact of ammonia in proportion to its potential impacts on threatened and endangered species and their habitats. See Morton, 458 F.2d at 834 ("The agency may limit its discussion of environmental impact to a

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[25] As mentioned supra in text, because the ammonia concentration in the analyzed environments is less than the Miami-Dade water quality standard, the NRC Staff "assumes that there would be no lethal effects or impairments to growth, survival, or reproduction [of endangered or threatened species]." Biological Assessment at 61; accord DSEIS at 4-66. Joint Intervenors offer no facts or expert opinions that impugn the NRC Staff's assumption.

brief statement, when that is the case, that the alternative course involves no effect on the environment, or that [an] effect, briefly described, is simply not significant.").[26]

In sum, Joint Intervenors fail to support their claim that different analytic treatment of species is not justified by the differing circumstances of the different species and their habitats, as required by 10 C.F.R. § 2.309(f)(1)(v), and they fail to demonstrate a genuine dispute of material law or fact, as required by 10 C.F.R. § 2.309(f)(1)(vi). Contention 5-Eb is therefore not admissible.

C. CONTENTION 6-E IS NOT ADMISSIBLE

Before we address the admissibility of Contention 6-E, we consider the following two threshold issues: (1) whether Contention 6-E requires a rule waiver pursuant to 10 C.F.R. § 2.335; and (2) whether Contention 6-E satisfies the good cause standard in 10 C.F.R. § 2.309(c). As discussed below, we conclude that a rule waiver is not required and that the good cause standard is satisfied.

1. A Rule Waiver Is Not Required Because Contention 6-E Does Not Challenge A Category 1 Issue.[27] Contention 6-E challenges the DSEIS's conclusion that the CCS's impacts

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[26] Joint Intervenors err in asserting that the NRC Staff's evaluation of ammonia's impacts on all threatened and endangered species must "consider '[s]everal water quality parameters, including pH, temperature, and salinity; the rate and duration of exposure; and a species' specific physiobiology[.]'" Joint Intervenors' Motion for New Contentions at 23 (emphasis omitted) (quoting Biological Assessment at 60). The above passage from the Biological Assessment quoted by Joint Intervenors was not addressing the scope of analysis required by NEPA; rather, it was addressing factors that can "affect the extent to which an organism experiences toxicity from [an elevated] level of ammonia." Biological Assessment at 60. Joint Intervenors fail to explain why a species that is not exposed to an elevated level of ammonia should be expected to experience ammonia toxicity.

[27] As discussed more fully in LBP-19-3, 89 NRC at __–__ (slip op. at 9–13), Category 1 issues are those environmental issues with effects that (1) are generic to all, or a specified group of, nuclear power plants; (2) have been analyzed in the Generic Environmental Impact Statement (GEIS), NUREG-1437, and codified by notice and comment rulemaking in 10 C.F.R. Part 51; (3) need not be addressed on a site-specific basis by a license renewal applicant in the ER or by the NRC Staff in the DSEIS; and (4) cannot be litigated in NRC adjudicatory proceedings unless a litigant obtains a rule waiver pursuant to 10 C.F.R. § 2.335. In contrast, Category 2 issues—i.e., environmental issues with effects that are not generic to all, or a

on adjacent surface waters via the groundwater pathway will be small during the SLR term. See Joint Intervenors' Motion for New Contentions at 40. Although Joint Intervenors argue that a rule waiver is not required, see Joint Intervenors' Petition for Waiver at [unnumbered] 6, they nevertheless filed a protective petition for a waiver of 10 C.F.R. § 51.53(c)(3) and 51.71(d), and Appendix B to 10 C.F.R. Part 51, Subpart A. See id. We conclude—in agreement with all the parties—that a rule waiver is not required.

When FPL prepared the ER, it treated the issue raised in Contention 6-E as a Category 1 issue based on its conclusion that "the Category 1 issue, 'Altered salinity gradients,' [was] applicable to Turkey Point[.]" DSEIS at 4-21. When the NRC Staff prepared the DSEIS, it determined that FPL should not have treated this matter as a Category 1 issue because "the GEIS (NUREG-1437) did not consider how a nuclear power plant [like Turkey Point Units 3 and 4] with a cooling pond in a salt marsh may indirectly impact the water quality of adjacent surface water bodies via a groundwater pathway." Id. As the NRC Staff explained, unlike the Category 1 configuration described in the GEIS, Turkey Point Units 3 and 4 are not located on an estuary where "changes in salinity [are] due to the operational effects of intake and discharge structures in estuaries." Id. at 4-22. Rather, "[a]t Turkey Point, the intake and discharge structures associated with Units 3 and 4 are located within the enclosed CCS, which does not directly discharge to the surface waters of Biscayne Bay." Id. Given Turkey Point's unique configuration, the NRC Staff concluded that the issue of "water quality impacts on adjacent water bodies (plants with cooling ponds in salt marshes)" is not a Category 1 issue, see id. at xvii, and the NRC Staff therefore analyzed the matter as a Category 2 issue. See id. at 4-21 to 4-23.

Under these circumstances, states the NRC Staff, Joint Intervenors need not obtain a rule waiver because Contention 6-E raises "a new issue that was not addressed in the GEIS as

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specified group of, nuclear power plants—must receive a plant-specific analysis in the ER and DSEIS, and these issues can be litigated in NRC adjudicatory proceedings.

. . . a Category 1 . . . issue." NRC Staff's Answer at 32 n.127; accord Tr. at 270 (NRC Staff concedes that a waiver is not required to adjudicate Contention 6-E). FPL likewise concedes that a rule waiver is not required to adjudicate Contention 6-E, see Tr. at 270, given "the NRC Staff's determination in the DSEIS to treat this as a new issue and to prepare a site-specific analysis (thereby treating the issue as the functional equivalent of a Category 2 issue)." FPL's Answer to Waiver Petition at 9. We agree that a rule waiver is not required because Contention 6-E does not challenge a Category 1 issue and, hence, does not raise an impermissible challenge to a regulation.

2. The Good Cause Standard in Section 2.309(c) Is Satisfied. Joint Intervenors argue that Contention 6-E satisfies the good cause standard, see supra Part II.A, and therefore is not time-barred. See Joint Intervenors' Motion for New Contentions at 31–40. The NRC Staff disagrees, arguing that Joint Intervenors "fail to demonstrate good cause for the filing of [Contention 6-E] almost nine months after the August 1, 2018 deadline for filing initial contentions," and pointing out that Joint Intervenors' expert, Dr. Fourqurean, relies on sources that existed "long before the deadline[.]" NRC Staff's Answer at 37. FPL similarly challenges the timeliness of Contention 6-E, asserting that Joint Intervenors "do not explain how any of [Dr. Fourqurean's] observations constitute new and materially different information, or why they could not have raised such concerns based on the ER." FPL's Answer to Contentions at 32 (emphasis omitted).

We conclude that the good cause standard is satisfied. Contention 6-E challenges the DSEIS's site-specific analysis and conclusion that the CCS's impacts on adjacent surface waters via the groundwater pathway would be small during the SLR term. Contrary to FPL's argument, see FPL's Answer to Contentions at 32, Joint Intervenors could not reasonably be expected to have raised this challenge based on the ER because the ER treated this matter as a Category 1 issue. See DSEIS at 4-21. The DSEIS, in contrast, viewed the matter as a Category 2 issue involving "new information" and requiring a new "site-specific analysis." Id.;

see also Joint Intervenors' Motion for New Contentions at 39 (new information in the DSEIS is "materially different from what [FPL] presented in the [ER]").

Contention 6-E's challenge is thus based on, and directed at, new information and analysis in the DSEIS that (1) was not previously available; and (2) is materially different from previously available information in the ER, thereby satisfying section 2.309(c)(1)(i) and (ii). Additionally, Joint Intervenors submitted Contention 6-E within the June 24, 2019 deadline established by this Board's April 2019 Scheduling Order, thereby satisfying the timeliness requirement in section 2.309(c)(1)(iii). The good cause standard is satisfied.[28]

3. Contention 6-E Is Not Admissible. Although Contention 6-E is timely and does not require a rule waiver, it fails to satisfy the admissibility standard in 10 C.F.R. § 2.309(f)(1). Contention 6-E states that "[t]he DSEIS fails to take the requisite 'hard look' at the impacts on surface waters via the groundwater pathway." Joint Intervenors' Motion for New Contentions at 40. This contention disputes the DSEIS's conclusion in section 4.5.1.1 that the CCS's impacts on adjacent surface water bodies via the groundwater pathway would be small during the SLR term, arguing that this conclusion is (1) based on unreliable modeling, see id.; (2) improperly substitutes the existence of enforcement requirements and oversight imposed by Florida's Consent Order and Miami-Dade County's Consent Agreement for a proper NEPA analysis, see

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28 The timeliness arguments advanced by the NRC Staff and FPL appear to focus on their assertion that the sources relied upon by Joint Intervenors' expert, Dr. Fourqurean, are neither new nor materially different from previously available information. See NRC Staff's Answer at 37; FPL's Answer to Contentions at 32. That may be true, but it is quite beside the point for purposes of analyzing the good cause standard here. The salient—and decisive—facts are that Joint Intervenors timely proffered a new contention based on new information in the DSEIS that is materially different from previously available information in the ER. See 10 C.F.R. § 2.309(c)(1)(i)–(iii).

Notably, at oral argument, counsel for FPL conceded that the good cause standard would not bar Joint Intervenors from challenging "a new analysis or new information" in the DSEIS. Tr. at 331. In our judgment, that concession fatally undercuts FPL's timeliness argument.

id.; and (3) is contradicted by new reports and an expert opinion submitted by Dr. Fourqurean on behalf of Joint Intervenors. See id. at 41–42, 44.

The NRC Staff and FPL argue that Contention 6-E fails to satisfy the contention admissibility standard in 10 C.F.R. § 2.309(f)(1). See NRC Staff's Answer at 32–38; FPL's Answer to Contentions at 34–39. We agree. We address the three components of Contention 6-E in turn.

a. The first component of Contention 6-E asserts that the NRC Staff relied on unreliable modeling when it concluded that the CCS's impacts on adjacent surface water bodies via the groundwater pathway will be small during the SLR term. In support of this assertion, Joint Intervenors cite to a single page in the DSEIS, see Joint Intervenors' Motion for New Contentions at 41 nn.172 & 173 (citing DSEIS at 3-49), and they make the following claims: (1) "[t]he DSEIS recognizes that [FPL's] efforts to reduce salinity in the [CCS] through the addition of water pumped from the Upper Floridan aquifer have been unsuccessful," id. at 41; (2) the "effort to 'freshen' the [CCS] did not achieve the 34 [practical salinity units (PSU)] annual average as predicted by [FPL's] modelers," id.; and (3) the DSEIS's conclusions regarding CCS salinity impacts are based on "unsupported assertions by [FPL's] modelers that more favorable climatic conditions will resolve the problem." Id. at 43–44. In our judgment, Joint Intervenors' claims are based on an erroneous view of the DSEIS's analyses and, accordingly, do not support the contention or give rise to a genuine dispute of material fact.

The DSEIS explains that FPL has numerically modeled CCS operation with a focus on quantifying the volumes of water and the mass of salt entering and exiting the CCS. See DSEIS at 3-49. The models are used as tools "to understand and predict different aspects of the CCS," including "the effectiveness of [FPL's] mitigation measures." Id.

The following passage from the DSEIS supports the conclusion that the NRC Staff independently assessed the reasonableness of FPL's modeling:

> The most recent modeling was conducted by Tetra Tech for FPL. The focus of this modeling was to quantify the volumes of water and the mass of salt entering and exiting the CCS (FPL 2012a). Model calculations for the various components of the CCS incorporate hydrological, chemical, and meteorological data collected in and around the CCS (FPL 2012a). Selected model inputs were adjusted to calibrate the model against observed changes in CCS water and salt storage. The calibration minimized differences between simulated and observed salt and water storage changes within the CCS. The calibration process builds confidence that the model will produce adequate predictions of CCS behavior (FPL 2014b).

DSEIS at 3-49.

As germane to Joint Intervenors' allegations underlying the first component of Contention 6-E, the DSEIS states in pertinent part:

> In 2014, Tetra Tech used numerical models to estimate the volume of Upper Floridan aquifer water that would be required to reduce CCS water salinity to seawater range. The modeling exercise produced an estimate that with the addition of 14 [million gallons per day (mgd)] (53,000 [cubic meters per day (m^3/day)]) of Upper Floridan aquifer water that had a salinity of 2 PSU it would require less than a year to reduce salinities in the CCS to 35 PSU (Tetra Tech 2014a). However, while FPL then added an average of 12.8 mgd (48,500 m^3/day) of Upper Floridan aquifer brackish water to the CCS from the beginning of November 2016 to the end of May 2017, salinities in the CCS did not go down to 35 PSU (FPL 2017a). Rather, at the end of May 2017, average salinity concentrations in the CCS were 64.9 PSU (FPL 2017b).
>
> Comparing CCS data and model results, the modelers concluded that during this period (most of which occurred during the dry season), evaporation rates exceeded precipitation rates. . . . However, the addition of Upper Floridan aquifer water helped to moderate the effects of the dry season (typically, November – April) on the CCS. For example, CCS salinities during the dry seasons of 2014 and 2015, which were not as dry as 2017, exceeded 90 PSU, while the addition of brackish water from the Upper Floridan aquifer and saltwater from the marine wells was effective in keeping CCS salinities below 70 PSU in the 2017 dry season. The modelers anticipate that under more favorable climatic conditions (e.g., less severe dry seasons), the addition of Upper Floridan aquifer water should help to reduce CCS water salinities to 34 PSU (FPL 2017a, FPL 2017b).

DSEIS at 3-49. Additionally, the DSEIS states that if FPL fails to reach an annual average salinity of 34 PSU or lower within four years of implementing freshening activities (i.e., by May 2021, see Tr. at 386, 416), the Consent Order with Florida requires FPL to submit a plan detailing additional mitigation measures, and a revised timeframe for achieving the salinity target. See id.[29]

Contrary to Joint Intervenors' claim, see Joint Intervenors' Motion for New Contentions at 41, a fair reading of the DSEIS does not establish that FPL's efforts to reduce the salinity in the CCS have been unsuccessful; rather, the DSEIS shows that FPL's freshening efforts have achieved a measure of success.[30] Nor, contrary to Joint Intervenors' speculation, see id., does the fact that FPL's freshening efforts have not yet achieved a CCS salinity level of 34 PSU raise a credible inference that FPL's model is fatally flawed or that its freshening efforts are ultimately doomed to failure.[31] Finally, contrary to Joint Intervenors' claim, id. at 43–44, the DSEIS does not indicate that FPL's model relies on more favorable climatic conditions in the future as an essential assumption for achieving a CCS salinity of 34 PSU; rather, the DSEIS discusses the

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29 The Consent Order between FPL and Florida states in relevant part:

> If FPL fails to reach an annual average salinity of at or below 34 PSU by the end of the fourth year of freshening activities [i.e., by May 2021, see Tr. at 386, 416], within 30 days of failing to reach the required threshold, FPL shall submit a plan to [Florida] detailing additional measures, and a timeframe, that FPL will implement to achieve the threshold. Subsequent to attaining the threshold in the manner set forth above, if FPL fails more than once in a 3 year period to maintain an average annual salinity of at or below 34 PSU, FPL shall submit, within 60 days of reporting the average annual salinity, a plan containing additional measures that FPL shall implement to achieve the threshold salinity level.

DSEIS at 3-47 (quoting Consent Order).

30 See DSEIS at 3-49 (observing that FPL's freshening efforts in the CCS during the 2017 dry season were effective in achieving a salinity level of 64.9 PSU, which is substantially lower than the greater-than-90 PSU level that existed in the 2014 and 2015 dry seasons that were wetter than the 2017 dry season).

31 As the DSEIS states, see DSEIS at 3-49, pursuant to the Consent Order with Florida, the targeted deadline for FPL to reach a CCS salinity level of 34 PSU is May 2021. See Tr. at 386, 416; supra note 29. The DSEIS also shows that the NRC Staff independently assessed the reasonableness of the model underlying the freshening plan upon which that deadline is based. See DSEIS at 3-49. Joint Intervenors fail to show a genuine dispute of material fact exists with regard to that timeline or the reasonableness of the model upon which that timeline is based.

observed effects of drier conditions, and the anticipated effects of less severe dry seasons, on the model predictions and results.[32]

Because we conclude that Joint Intervenors' assertions in support of the first component of Contention 6-E are based on an erroneous view of the DSEIS's analyses, that aspect of Contention 6-E is inadmissible for failing to provide the necessary support, as required by 10 C.F.R. § 2.309(f)(1)(v), and for failing to show a genuine dispute on a material issue of law or fact, as required by 10 C.F.R. § 2.309(f)(1)(vi).

b. The second component of Contention 6-E asserts that the NRC Staff's conclusion in section 4.5.1.1 of the DSEIS that the CCS's impacts on adjacent surface water bodies via the groundwater pathway will be small improperly "substitutes the existence of permit requirements and oversite [sic] [by Florida and Miami-Dade County] for a proper NEPA analysis." Joint Intervenors' Motion for New Contentions at 40; see also id. at 43 ("The NRC Staff's conclusion [incorrectly] presumes that compliance with the [Florida] Consent Order and the Miami-Dade Consent agreement will effectively manage salinity conditions in the [CCS] and therefore prevent adverse impacts on adjacent surface water bodies."). We conclude that this aspect of Contention 6-E is inadmissible for two reasons.

First, contrary to Joint Intervenors' assertion, the NRC Staff did not—in abdication of its NEPA responsibilities—base its conclusion in section 4.5.1.1 of the DSEIS solely on the existence of enforcement requirements and continuing oversight of Florida and Miami-Dade County. As discussed supra Part III.C.3.a, the NRC Staff's conclusion is based, inter alia, on (1) the Staff's independent assessment of FPL's modeling for freshening the CCS; and (2) the

[32] See DSEIS at 3-49. As counsel for the NRC Staff observed, the reference in the DSEIS about "more favorable climatic conditions" was "a qualitative statement" recognizing that "weather conditions can affect the outcomes." Tr. at 372–73. We agree that the reference, reasonably read in context, simply "indicate[s] that a return to more . . . historically normal weather conditions, would result in more favorable conditions in the CCS." Id. at 374.

Staff's review of FPL's freshening plans and its progress in achieving freshening goals.[33] Because this aspect of Contention 6-E fails to acknowledge the full basis underlying the NRC Staff's conclusion in section 4.5.1.1 of the DSEIS, it is grounded on an erroneous factual predicate, which renders it inadmissible for failing to provide the necessary factual support, as required by 10 C.F.R. § 2.309(f)(1)(v), and for failing to show a genuine dispute on a material issue of law or fact, as required by 10 C.F.R. § 2.309(f)(1)(vi).

Second, insofar as Joint Intervenors suggest that NEPA proscribes the NRC Staff from considering enforcement requirements and oversight activities by local authorities when preparing the DSEIS, they are incorrect as a matter of law. As we explained in a previous decision in this case:

> Pursuant to binding case law, we accord "substantial weight" to the determination of [Florida and Miami-Dade County] that FPL will comply with its legal obligations. See Pub. Serv. Co. of N.H. (Seabrook Station, Units 1 & 2), CLI-77-8, 5 NRC 503, 527 (1977) (holding that a finding of environmental acceptability made by a competent state authority pursuant to a thorough hearing "is properly entitled to substantial weight in the conduct of our own NEPA analysis.") ([brackets omitted and] internal quotation marks omitted); cf. Pac. Gas & Elec. Co. (Diablo Canyon Power Plant, Units 1 & 2), CLI-03-2, 57 NRC 19, 29 (2003) (absent evidence to the contrary, Commission will assume that licensee will comply with license obligations). FPL's past violations in this case, standing alone, do not constitute sufficient information to give rise to a genuine dispute with the assumption that [Florida and Miami-Dade County] will enforce, and FPL will comply with, the legally mandated mitigation measures . . . . See Fla. Power & Light Co. (Turkey Point Nuclear Generating Units 3 & 4), CLI-16-18, 84 NRC 167, 174–75 n.38 (2016).

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[33] The DSEIS also describes the structure and physical operation of the CCS, see DSEIS § 3.1.3.2; the CCS's connection with Biscayne Aquifer groundwater, see id.; and the Biscayne Aquifer's connection with surface water in Biscayne Bay and Card Sound. See, e.g., id. §§ 3.5.1, 3.5.1.1, 4.5.1.1. The DSEIS describes recent studies to evaluate potential effects of CCS operations via the movement of groundwater from the CCS to adjacent surface water bodies and explains that, in response to enforcement requirements imposed by Florida and Miami-Dade County, "FPL conducts an extensive water quality monitoring program that includes the CCS, Biscayne Bay, Card Sound, marshland, mangrove areas, and canals adjacent to the CCS." Id. § 3.5.1.4. These discussions in the DSEIS support the conclusion that the NRC Staff complied with NEPA's "hard look" requirement when assessing the impacts on surface water via the groundwater pathway, which, in turn, belies Joint Intervenors' assertion that the NRC Staff "substitute[d]" the existence of enforcement and oversight by Florida and Miami-Dade County for a proper NEPA analysis. See Joint Intervenors' Motion for New Contentions at 40.

LBP-19-3, 89 NRC at __ (slip op. at 38).[34] To the extent that Contention 6-E attacks the NRC Staff's consideration of the enforcement and oversight activities of Florida and Miami-Dade County, it is inadmissible for failing to show a genuine dispute on a material issue of law, as required by 10 C.F.R. § 2.309(f)(1)(vi).

c. The third component of Contention 6-E asserts that new reports and an expert opinion submitted by Dr. Fourqurean contradict the DSEIS's conclusion in section 4.5.1.1 that the CCS's impacts on adjacent surface water bodies via the groundwater pathway will be small. See Joint Intervenors' Motion for New Contentions at 41–42, 44. However, except for their reference to Dr. Fourqurean's expert opinion, see id. at 44, Joint Intervenors fail to specify any "new report" (much less a specific statement in a new report) to support the contention's assertion. This failure renders the third component of Contention 6-E inadmissible to the extent it purports to rely on unidentified "new reports," because it fails to provide supporting facts, as required by 10 C.F.R. § 2.309(f)(1)(v). As the Commission has admonished:

> [I]t is not up to our [licensing] boards to search through pleadings or other materials to uncover arguments and support never advanced by the petitioners themselves; . . . . It is a "contention's proponent, not the licensing board," that "is responsible for formulating the contention and providing the necessary information to satisfy [its] . . . admission[.]"

USEC Inc. (American Centrifuge Plant), CLI-06-10, 63 NRC 451, 457 (2006) (quoting Statement of Policy on Conduct of Adjudicatory Proceedings, CLI-98-12, 48 NRC 18, 22 (1998)).

Regarding Dr. Fourqurean's opinion, Joint Intervenors make a passing reference to "phosphorus loadings attributable to the [CCS]" and assert broadly that Dr. Fourqurean's report "demonstrates impacts on water quality in Biscayne Bay via the groundwater pathway are impacting seagrass communities and that continued operation of the [CCS] is likely to violate

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[34] In the same decision, we observed that an agency's NEPA responsibilities can include the review of relevant enforcement and oversight activities. See LBP-19-3, 89 NRC at __ n.56 (slip op. at 38 n.56). Joint Intervenors provide no factual basis for concluding that the NRC Staff's NEPA review in the instant case was deficient. See, e.g., DSEIS at 3-47, 3-62 to 3-73 (discussing enforcement and oversight activities of Florida and Miami-Dade County).

narrative water quality standards." Joint Intervenors' Motion for New Contentions at 42, 44. This concern with phosphorous loadings overlooks that, as discussed in the DSEIS, in May 2016, FPL submitted to Florida the monitoring results from certain surface water monitoring stations in channels adjacent to the CCS for certain nutrients, including total phosphorus, and Florida "reviewed this information and determined that no exceedances of surface water quality standards were detected in the Biscayne Bay monitoring[.]" DSEIS at 3-51. Joint Intervenors (and Dr. Fourqurean) simply speculate that phosphorus in Biscayne Bay must originate from the CCS (as opposed to other known sources, such as agricultural runoff, see DSEIS at 3-50), and they speculate that water quality violations are "likely." See Joint Intervenors' Motion for New Contentions at 44. Such speculation, however, does not constitute the factual support required by section 2.309(f)(1)(v), nor does it raise a genuine dispute with the DSEIS on a material issue of law or fact, as required by section 2.309(f)(1)(vi).[35] This component of Contention 6-E is therefore not admissible.

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[35] In support of Contention 6-E, Joint Intervenors make the cursory assertion that Dr. Fourqurean's report demonstrates that CCS operations—specifically the discharge of nutrients, including phosphorus, into Biscayne Bay—are impacting seagrass communities and are likely to violate water quality standards. See Joint Intervenors' Motion for New Contentions at 42, 44. Joint Intervenors fail to acknowledge, however, that the DSEIS discusses nutrients (including phosphorus) in the CCS, see DSEIS at 3-42 to 3-44; the source of nutrients in the CCS, see id. at 3-44; the adverse impacts of nutrients on the environment, including seagrass, see id. at 3-44, 3-50; how those impacts have changed over time, see id. at 3-44; and FPL's efforts to monitor and address CCS nutrient impacts to groundwater and surface water resources. See id. at 3-48 to 3-53. Nor does Contention 6-E acknowledge the nutrient management plan that FPL implemented in 2017 pursuant to its Consent Order with Florida. That plan "is composed of three primary nutrient management strategies: (1) active algae and nutrient removal, (2) canal and berm maintenance, and (3) salinity reduction and controlled flow management." Id. at 3-44. As the DSEIS explains:

> Under this nutrient management plan, FPL has performed bench and pilot tests to find the most appropriate active nutrient and algae removal methods for the unique ecology and water chemistry of the CCS. These nutrient and algae removal methods include using chemical flocculants/coagulants, nonchemical means (i.e., physical removal), and aeration. In addition, FPL reviewed Turkey Point canal practices in order to revise them to integrate the goal of minimizing erosion and nutrient inputs from sediment and berm sources (FPL 2017b).

D. CONTENTION 7-E CHALLENGES A CATEGORY 1 ISSUE, AND JOINT INTERVENORS FAIL TO SATISFY THE RULE WAIVER CRITERIA IN 10 C.F.R. § 2.335[36]

Contention 7-E states that "[t]he DSEIS fails to take the requisite 'hard look' at impacts to groundwater quality." Joint Intervenors' Motion for New Contentions at 44. This contention challenges a Category 1 issue—i.e., "groundwater quality degradation (plants with cooling ponds in salt marshes)." 10 C.F.R. pt. 51, subpt. A, app. B, table B-1. We must therefore determine whether Joint Petitioners have satisfied the "substantial burden" imposed by 10 C.F.R. § 2.335 of demonstrating that a rule waiver is warranted. See Limerick, CLI-13-7, 78 NRC at 208.

Joint Intervenors urge us to resolve this issue in the affirmative, arguing that they satisfy the four-factor Millstone test, see supra Part II.C, for obtaining a rule waiver. See Joint Intervenors' Petition for Waiver at 6–10 (unnumbered).[37] The NRC Staff and FPL argue that the

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Id. The DSEIS further states that "[t]he impact of . . . nutrients on water quality has been the focus of CCS operational concerns." Id. at 4-22. Although increased levels of nutrients reportedly have been "found in local areas adjacent to the CCS, . . . discernable effects from CCS derived . . . nutrients . . . on Biscayne Bay or Card Sound water qualities [have] not been detected." Id. In light of the above, and "upon consideration of [Florida's and Miami-Dade County's] existing requirements and their continuing oversight of FPL's remediation efforts," the NRC Staff concluded that CCS impacts on adjacent surface water bodies during the SLR term will be small. Id. at 4-23. Nothing in Joint Intervenors' discussion of Contention 6-E demonstrates a genuine dispute of material law or fact with the above discussions and conclusions, as required by section 2.309(f)(1)(vi).

[36] As discussed supra note 27, a Category 1 issue is not subject to challenge in an NRC adjudicatory proceeding unless a petitioner obtains a section 2.335 rule waiver.

[37] Joint Intervenors also argue that a waiver is not required because "[n]o NRC regulation prohibits intervenors from challenging new information identified and evaluated by the NRC Staff in a DSEIS with respect to a Category 1 issue." Joint Intervenors' Petition for Waiver at 6 (unnumbered). We summarily reject this argument as foreclosed by Commission case law. See e.g., Exelon Generation Co. (Limerick Generating Station, Units 1 & 2), CLI-12-19, 76 NRC 377, 384 n.39 (2012) ("Fundamentally, any contention on a 'Category 1' issue amounts to a challenge to our regulation that bars challenges to generic environmental findings.") (quoting Entergy Nuclear Vermont Yankee, LLC, and Entergy Nuclear Operations, Inc. (Vermont Yankee Nuclear Power Station), CLI-07-3, 65 NRC 13, 20 (2007)).

Millstone test is not satisfied and, accordingly, that we must reject Contention 7-E because it is an impermissible challenge to a Commission regulation and, thus, outside the scope of this proceeding. See NRC Staff's Answer at 56–58; FPL's Answer to Waiver Petition at 10–18. We agree with the NRC Staff and FPL.[38]

As discussed supra Part II.C, the Commission uses the four-factor Millstone test for resolving rule waiver petitions. Pursuant to that test, to obtain a rule waiver, Joint Intervenors must show the following:

> (i) the rule's strict application would not serve the purposes for which it was adopted;
>
> (ii) the movant has alleged special circumstances that were not considered, either explicitly or by necessary implication, in the rulemaking proceeding leading to the rule sought to be waived;
>
> (iii) those circumstances are unique to the facility rather than common to a large class of facilities; and
>
> (iv) a waiver of the regulation is necessary to reach a significant safety [or environmental] problem.

Millstone, CLI-05-24, 62 NRC at 559–60 (2005) (internal quotations omitted). Joint Intervenors' waiver request founders fatally on the first Millstone factor.

Joint Intervenors argue that the first Millstone factor is satisfied because "[a]llowing a petitioner to challenge the adequacy of analysis pertaining to new information regarding a Category 2 issue while preventing such challenge with respect to new information regarding a Category 1 issue . . . would not serve the purposes for which sections 51.53(c)(3) and 51.71(d) and Appendix B were adopted." Joint Intervenors' Petition for Waiver at 7–8 (unnumbered). Joint Intervenors argue further that "prevent[ing] challenges to analysis of new information would be contrary to NEPA's requirement that agencies 'broad[ly] disseminat[e]' information to

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[38] The NRC Staff and FPL also argue that Contention 7-E should be rejected on timeliness grounds for failing to satisfy the good cause standard in 10 C.F.R. § 2.309(c). See NRC Staff's Answer at 42; FPL's Answer to Contentions at 40. Because we reject Contention 7-E as an impermissible challenge to a Category 1 issue, we need not consider the timeliness issue.

'permit[] the public and other government agencies to react to the effects of a proposed action at a meaningful time.'" Id. at 7 (unnumbered) (quoting Marsh v. Or. Nat. Res. Council, 490 U.S. 360, 371 (1989)).

Although new information related to a Category 1 issue may provide a basis for satisfying the first Millstone factor, Joint Intervenors are incorrect to the extent they argue that new information will always satisfy that factor.[39] Rather, a "petitioner must show that new and significant information, unique to a particular plant, exists . . . such that the Category 1 finding in 10 C.F.R. Part 51, Subpart A, Appendix B should be waived to litigate the issue in a site-specific proceeding." Limerick, CLI-13-7, 78 NRC at 213 (emphasis added). The Commission has stated that its designation of an environmental issue as a Category 1 issue "reflects the NRC's expectations that our NEPA obligations have been satisfied with reference to our previously conducted environmental analysis in the GEIS." Id. at 212–13. Applying that statement to the present context—in particular, to the first Millstone factor—the Commission's designation of "groundwater quality degradation (plants with cooling ponds in salt marshes)" as a Category 1 issue whose environmental impacts would be "small" during the SLR period, 10 C.F.R. pt. 51,

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[39] Joint Intervenors appear to argue that the mere existence of new information regarding a Category 1 issue satisfies the first Millstone factor because (1) such information essentially transforms a Category 1 issue into a Category 2 issue; and (2) a contrary conclusion would contravene NEPA. See Joint Intervenors' Petition for Waiver at 7–8 (unnumbered). The first rationale is foreclosed by Commission case law, which holds that "a waiver [is] required to litigate any new and significant information relating to a Category 1 issue," because "'[a]djudicating Category 1 issues site by site based merely on a claim of 'new and significant information,' would defeat the purpose of resolving generic issues in a GEIS.'" Limerick, CLI-12-19, 76 NRC at 384 (quoting Vermont Yankee, CLI-07-3, 65 NRC at 21). That new information has been identified does not, contrary to Joint Intervenors' understanding, automatically convert an issue from Category 1 to Category 2. Joint Intervenors' second rationale is likewise foreclosed by the reasoning in the above-cited Limerick decision, CLI-12-19, as well as by federal appellate case law, which holds that the NRC's "divergent treatment of generic and site-specific issues is reasonable" and permitted by NEPA. Massachusetts v. NRC, 522 F.3d 115, 120 (1st Cir. 2008); see also NRDC v. NRC, 823 F.3d 641, 652 (D.C. Cir. 2016) (holding that the NRC's rule waiver process for Category 1 issues comports with NEPA, which "'does not mandate particular hearing procedures and does not require hearings'") (quoting Beyond Nuclear v. NRC, 704 F.3d 12, 18–19 (1st Cir. 2013)).

subpt. A, app. B, table B-1, "reflects the NRC's expectations that [its] NEPA obligations have been satisfied with reference to [its] previously conducted environmental analysis in the GEIS." Limerick, CLI-13-7, 78 NRC at 212–13.

Accordingly, in our judgment, the purpose of the NRC's designation of "groundwater quality degradation (plants with cooling ponds in salt marshes)" as a Category 1 issue is satisfied here unless Joint Intervenors show that new information is significant insofar as it would lead to a determination that the environmental impact during the SLR period will be greater than "small." 10 C.F.R. pt. 51, subpt. A, app. B, table B-1. Such a showing would evince a conclusion, consistent with the first Millstone factor, that the strict application of the Category 1 issue being challenged in Contention 7-E would not serve the purpose for which it was adopted. See FPL's Answer to Waiver Petition at 14–15; Tr. at 284, 287–88, 304–05, 307. Joint Intervenors failed to make this showing. See supra note 39.

Joint Intervenors nevertheless opine that they "have not yet had an opportunity to review or challenge the sufficiency of [the DSEIS's analysis of new information]." Joint Intervenors' Petition for Waiver at 7 (unnumbered). To satisfy section 2.335(b), however, they had an obligation to provide sufficient information, via their petition and accompanying affidavit, to satisfy the four Millstone factors, including a showing that the environmental impact to groundwater quality from operation of the CCS during the SLR period would be greater than small. This they failed to do.

Because Joint Intervenors failed to satisfy the first Millstone factor, we deny their petition for a rule waiver. Absent a rule waiver, Contention 7-E is outside the scope of this proceeding, see 10 C.F.R. § 2.309(f)(1)(iii), because it constitutes an impermissible challenge to a Commission regulation. See id. § 2.335(a).

E. CONTENTION 8-E IS NOT ADMISSIBLE

In Contention 8-E, Joint Intervenors assert that "[t]he DSEIS fails to take the requisite 'hard look' at cumulative impacts on water resources." Joint Intervenors' Motion for New

Contentions at 47. They specifically challenge the NRC Staff's conclusion that FPL's "'freshening system, combined with proper operation and maintenance of the [CCS], will result in no substantial contribution to cumulative impacts on groundwater quality or associated impacts on surface water quality in Biscayne Bay during the [SLR] period.'" See id. at 48 (quoting DSEIS at 4-117). Joint Intervenors ground their challenge on the following two premises: (1) the NRC Staff improperly relies on FPL's "remediation and freshening efforts" that, according to Joint Intervenors, will not be successful, id. at 49; and (2) the NRC Staff "unlawfully substitutes the existence of state and county requirements and oversite [sic] for a proper NEPA analysis." Id.

The NRC Staff and FPL argue that Contention 8-E fails to satisfy the contention admissibility standard in 10 C.F.R. § 2.309(f)(1). See NRC Staff's Answer at 43–45; FPL's Answer to Contentions at 42–43.[40] We agree.

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[40] The NRC Staff and FPL also argue that Contention 8-E fails to satisfy the good cause standard in section 2.309(c), see supra Part II.A, because Joint Intervenors did not timely file previously available information. See NRC Staff's Answer at 45; FPL's Answer to Contentions at 42. We reject this argument for the reasons discussed supra note 28; namely, Joint Intervenors timely proffered a new contention based on, and directed at, new information in the DSEIS that was not in the ER—i.e., the NRC Staff's analysis of cumulative impacts on water resources caused by the CCS and the hypersaline plume. See Joint Intervenors' Motion for New Contentions at 48 (quoting DSEIS at 4-117); accord id. at 25; Tr. at 439–40.

We also decline FPL's invitation to reject Contention 8-E as an impermissible challenge to a Category 1 issue. See FPL's Answer to Contentions at 42. Commission regulations explicitly designate "cumulative impacts" as a Category 2 issue that can be challenged in NRC adjudicatory proceedings. See 10 C.F.R. pt. 51, subpt. A, app. B, table B-1. Although a petitioner may not improperly cloak a Category 1 issue with a Category 2 label and thereby avoid the rule waiver requirement in section 2.335, see Tr. at 441–42, 448–49; cf. LBP-19-3, 89 NRC at __ (slip op. at 37) (rejecting as Contention 1 issues discrete components of an environmental contention that purported to challenge the ER's cumulative impacts analysis), we agree with the NRC Staff and Joint Intervenors that Contention 8-E does not suffer from that infirmity. See Tr. at 441 (counsel for NRC Staff states that Contention 8-E raises a "Category 2 site-specific issue"); Joint Intervenors' Motion for New Contentions at 48 (Contention 8-E challenges "a Category 2 issue that is subject to a site-specific analysis"). Rather, as discussed in the above paragraph, Contention 8-E focuses on the NRC Staff's analysis of cumulative impacts on water resources caused by the CCS and the hypersaline plume, implicating issues that are akin to the Category 2 issue in Contention 6-E. See supra Part III.C.

1. Regarding the first premise underlying Contention 8-E, Joint Intervenors argue that the NRC Staff improperly relies on the success of FPL's remediation and freshening efforts for the conclusion that the cumulative impacts of the operation of Turkey Point Units 3 and 4 during the SLR period on groundwater and surface water quality in Biscayne Bay will be insubstantial. See Joint Intervenors' Motion for New Contentions at 48–49. In particular, Joint Intervenors contest the DSEIS's conclusion that "[FPL's] recovery well system will be 'successful' in retracting the hypersaline plume before the end of the current license period[.]" Id. at 48.

At the outset, we note that Joint Intervenors fail to specify any factual statement, document, or expert opinion to support this aspect of the contention. This failure alone renders Contention 8-E inadmissible. As the Commission has declared, "[i]t is a 'contention's proponent, not the licensing board,' that 'is responsible for formulating the contention and providing the necessary information to satisfy [its] . . . admission.'" USEC Inc. (American Centrifuge Plant), CLI-06-10, 63 NRC at 457 (quoting Statement of Policy on Conduct of Adjudicatory Proceedings, CLI-98-12, 48 NRC at 22).[41]

In any event, Joint Intervenors provide no support for their assertion that the NRC Staff failed to take NEPA's required "hard look" at the proposed action's cumulative impacts on water resources. Joint Intervenors point to a portion of a single sentence in the DSEIS, which says in full:

> As stated in Section 4.5.1.2 of this [DSEIS], current modeling projections indicate that FPL's recovery well system will be successful in retracting the hypersaline plume back to within the boundaries of the CCS within 10 years of the startup

[41] We acknowledge that Joint Intervenors' motion includes a section (Section IV.B) entitled "New Information" that summarizes their "expert opinions" and "new reports." See Joint Intervenors' Motion for New Contentions at 25–31. In the section of their motion arguing that Contention 8-E satisfies the admissibility requirement in section 2.309(f)(1)(v) (i.e., Section IV.F), Joint Intervenors include a solitary citation (without any discussion or explanation) to Section IV.B. See id. at 49. This passing and non-descript reference to a lengthy section in their motion fails to satisfy section 2.309(f)(1)(v), which requires a petitioner to provide "a concise statement of the alleged facts or expert opinions" that support the contention, along with "references to the specific sources and documents[.]" 10 C.F.R. § 2.309(f)(1)(v).

> (i.e., by about 2028) while also retracting the saltwater interface back to the east from its current location.

DSEIS at 4-116; see Joint Intervenors' Motion for New Contentions at 48. But that sentence does not address, much less impugn, the NRC Staff's review of the relevant groundwater modeling. In this regard, the DSEIS states as follows:

> In order to stop and then retract the westward migration of hypersaline groundwater originating from the CCS, the 2016 [Florida] Consent Order requires FPL to permit, construct, and operate a recovery well system to remediate the hypersaline plume in the Biscayne aquifer. This requirement is also consistent with the 2015 Consent Agreement between FPL and Miami-Dade County . . . .
>
> * * * *
>
> In its [ER], FPL stated that groundwater modeling of the recovery well system operation indicates that the westward migration of the hypersaline plume will be stopped in 3 years of operation, with retraction of the hypersaline plume north and west of the CCS beginning in 5 years. FPL further projects that system operation will achieve retraction of the plume back to the FPL site boundary within 10 years, as required by the 2016 [Florida] Consent Order . . . . FPL is required to conduct periodic continuous surface electromagnetic mapping surveys to delineate the extent of the hypersaline plume in order to measure the success of recovery and remediation efforts and report the results to [Florida]. After 5 years of system operation, FPL must provide a report to [Florida] that evaluates the effectiveness of the recovery well system in retracting the hypersaline plume to the L-31E Canal within 10 years. If FPL's report shows that the remediation efforts will not retract the hypersaline plume to the L-31E Canal within 10 years, FPL must develop and submit an alternative plan to [Florida] for its approval.

DSEIS at 3-70 to 3-71 (citations omitted); see also id. at 3-73 (discussing FPL's modeling "analysis using the variable density, three-dimensional groundwater model . . . to 'allocate relative contributions of other entities or factors to the movement of the saltwater interface'"); id. at 4-27.

The DSEIS also reviewed the layout, operation, and efficacy of the hypersaline groundwater recovery well system:

> The installed full-scale hypersaline groundwater recovery wells system consists of 10 hypersaline groundwater recovery (extraction) wells (i.e., numbered RW-1 through RW-10), generally located along the western edge of the CCS, and the Class 1 deep injection well (DIW-1) for disposal of the recovered hypersaline groundwater . . . . Between September 2016 and May 2018, the testing and recovery well systems have extracted and disposed of approximately 8,285

> million gallons (31.4 million [cubic meters]) of hypersaline groundwater, with the removal of 1.92 million tons (1.74 million metric tons) of salt from the Biscayne aquifer. Section 3.5.2.3, "Groundwater Use," provides additional details on the groundwater well system.

DSEIS at 3-70 (citation omitted); see also id. at 3-67 to 3-73 (discussing FPL's groundwater monitoring program).

The DSEIS acknowledged that groundwater models "entail substantial uncertainty" because they are "approximations of natural systems and are dependent on a number of input variables based on assumptions regarding present and future environmental conditions." DSEIS at 4-27. Nevertheless, based on the NRC Staff's review of (1) FPL's groundwater modeling and modeling results; (2) the operation and efficacy of FPL's hypersaline groundwater recovery well system; (3) FPL's groundwater monitoring program; and (4) the regulatory enforcement and oversight of Florida and Miami-Dade County, the NRC Staff concluded that FPL's groundwater remediation efforts would be successful. See id. at 4-27 to 4-28; 4-116 to 4-117. Joint Intervenors do not specify a deficiency in the NRC Staff's review, nor do they provide the necessary support to show the existence of a genuine dispute of material law or fact. This aspect of Contention 8-E is therefore not admissible pursuant to 10 C.F.R. § 2.309(f)(1)(vi).[42]

2. Regarding the second premise underlying Contention 8-E, Joint Intervenors assert that the NRC Staff "unlawfully substitutes the existence of state and county requirements and oversite [sic] for a proper NEPA analysis." Joint Intervenors' Motion for New Contentions at 49. This is the identical argument that Joint Intervenors advanced in support of Contention 6-E, and we reject it here for the same two reasons that we rejected it there. See supra Part III.C.3.b. First, contrary to Joint Intervenors' assertion, the NRC Staff did not base its cumulative impacts conclusion in section 4.16.2.1 of the DSEIS solely on the existence of state

[42] In support of their assertion that Contention 8-E raises a genuine dispute on a material issue of law or fact, Joint Intervenors rely on the information and arguments they advanced in support of Contention 6-E. See Joint Intervenors' Motion for New Contentions at 49. That reliance is misplaced in light of our conclusion, see supra Part III.C.3, that Contention 6-E fails to satisfy section 2.309(f)(1)(vi).

and county enforcement requirements and oversight. Rather, as discussed supra Part III.E.1, the NRC Staff also considered (1) FPL's groundwater modeling and modeling results; (2) the operation and efficacy of FPL's hypersaline groundwater recovery well system; and (3) FPL's groundwater monitoring program. Insofar as Contention 8-E fails to acknowledge all the factors underlying the NRC Staff's cumulative impacts conclusion, it is based on an erroneously incomplete factual predicate, which renders it inadmissible for failing to provide supporting alleged facts, as required by section 2.309(f)(1)(v), and for failing to show a genuine dispute on a material issue of law or fact, as required by section 2.309(f)(1)(vi).

Second, and in any event, Joint Intervenors are incorrect as a matter of law in their notion that NEPA proscribes the NRC Staff from considering local enforcement and oversight activities when preparing the DSEIS. See supra text accompanying note 34. Contention 8-E is therefore not admissible.

F. CONTENTION 9-E IS NOT ADMISSIBLE

In Contention 9-E, Joint Intervenors assert that "[t]he DSEIS fails to take the requisite 'hard look' at impacts to groundwater use conflicts." Joint Intervenors' Motion for New Contentions at 49. This contention disputes the NRC Staff's conclusion in section 4.5.1.2 that impacts on groundwater use conflicts from continued operation of the Turkey Point units during the SLR period will be small for the Biscayne aquifer and moderate for the Upper Floridan aquifer. See id. at 51. According to Joint Intervenors, "the rate of groundwater withdrawal necessary to hit salinity targets and retract the hypersaline plume is substantially higher than evaluated in the DSEIS," id. at 52, which will result in greater groundwater use conflicts than contemplated in the DSEIS. See id. To support this contention, Joint Intervenors rely on the expert opinion of Mr. E.J. Wexler. See id. at 52 nn.206 & 207 (citing to Declaration of E.J. Wexler at 2 (June 28, 2019) [hereinafter Wexler Decl.]).[43]

The NRC Staff and FPL argue that Contention 9-E fails to satisfy the contention admissibility standard in 10 C.F.R. § 2.309(f)(1). See NRC Staff's Answer at 47–51; FPL's Answer to Contentions at 45–47.[44] We agree.

Joint Intervenors' sweeping assertion that the DSEIS fails to take a hard look at impacts on groundwater use conflicts ignores the DSEIS's extensive consideration of that topic. See Joint Intervenors' Motion for New Contentions at 49–50. The DSEIS's analyses of groundwater use conflicts for the Biscayne and Upper Floridan aquifers include detailed discussions on FPL's water withdrawal rates, see DSEIS at 4-28 to 4-33; the relevant State water withdrawal permits and authorizations, see id. at 4-29 to 4-31; FPL's legal obligations under those permits and authorizations, including withdrawal allocations and mitigative actions to avoid harm to other groundwater users, see id. at 4-29 to 4-32; and the specific modeling and confirmatory evaluations performed by FPL and State regulators to support issuance of the permits.[45] See id. at 4-29 to 4-33.

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43 In support of Contention 9-E, Joint Intervenors also argue that the NRC Staff "unlawfully substitute[d] the existence of state and county requirements and oversite [sic] for a proper NEPA analysis." Joint Intervenors' Motion for New Contentions at 50. For the reasons discussed supra Parts III.C.3.b and III.E.2, this argument lacks merit.

44 The NRC Staff and FPL also argue that Contention 9-E fails to satisfy the good cause standard in section 2.309(c), see supra Part II.A, because Joint Intervenors did not timely file previously available information. See NRC Staff's Answer at 51–52; FPL's Answer to Contentions at 44–45. We reject this argument for the reasons discussed supra notes 28 and 40; namely, Joint Intervenors timely proffered a new contention based on, and directed at, new information in the DSEIS that was not in the ER—i.e., the NRC Staff's discussion of groundwater modeling as it relates to groundwater use conflicts. See Joint Intervenors' Motion for New Contentions at 51–52; accord id. at 25.

45 Significantly, the DSEIS states that Florida reviewed FPL's groundwater modeling, and it also performed confirmatory analyses that included a modeling scenario under drought conditions. See DSEIS at 4-29 to 4-30. The NRC Staff independently reviewed this material. See, e.g., id. at 4-29 ("The NRC Staff reviewed the modeling report (Tetra Tech 2016) as well as the [Florida] report and impacts evaluation that were included in FPL's water use individual permit (Permit No. 13-06251-W) (SFWMD 2017a).").

Informed by the above analyses in the DSEIS, the NRC Staff made the following determination:

> [FPL reasonably] predicts retraction of the westward [hypersaline] plume to the edge of the CCS by about 5 years and complete retraction within 10 years (i.e., by about 2028), with minor aquifer drawdown impacts. Thus, FPL would achieve the compliance deadline for retraction of the hypersaline plume and its effect on the location of the regional saltwater interface, as set forth in its 2016 consent order with [Florida] (FDEP 2016e), without undue impact on groundwater resources or producing unintended groundwater use conflicts.

DSEIS at 4-30; accord id. at 4-32.

The NRC Staff summarized its groundwater use conflicts evaluation as follows:

> In summary, based on the evaluation presented above, the NRC Staff anticipates that operation of the recovery well system will not result in any interference with existing permitted uses of groundwater, will not impact natural resources, and will not result in lateral movement of the saltwater interface in the Biscayne aquifer. Further, intermittent operation of FPL's marine wells is not expected to substantially alter groundwater flow or result in any substantial drawdown in the Biscayne aquifer. For the Upper Floridan aquifer, groundwater modeling performed to evaluate aquifer response from continued operation of FPL's freshening well system indicates the potential for appreciable drawdowns in offsite production wells, including in potable water wells located approximately 10 [miles] (16 [kilometers]) from the Turkey Point site. While the projected drawdowns would be noticeable in affected offsite wells, the effects would not be expected to affect water availability or impair the Upper Floridan aquifer as a resource. Consistent with these impacts, the NRC Staff concludes that the potential for groundwater use conflicts from FPL's groundwater withdrawals would be SMALL for the Biscayne aquifer and MODERATE for the Upper Floridan aquifer during the [SLR] term.

DSEIS at 4-33.

Notwithstanding the NRC Staff's consideration of the groundwater use conflicts issue, Joint Intervenors dispute the NRC Staff's conclusions regarding potential groundwater use conflicts for the Biscayne and Upper Floridan aquifers, asserting that the Wexler Declaration supports the following two premises upon which Contention 9-E is grounded: (1) FPL's effort to reduce the CCS salinity to 34 PSU is not working and is unlikely to work in the future; and (2) FPL's effort to mitigate the hypersaline plume is not working and is unlikely to work in the future. See Joint Intervenors' Motion for New Contentions at 52. Based on these two premises, Joint Intervenors claim that FPL's groundwater withdrawal for CCS freshening and plume mitigation will be substantially higher than evaluated in the DSEIS, which will give rise to greater groundwater use conflicts than the DSEIS contemplated. See id. Joint Intervenors fail, however, to support these two premises, and thus they fail to raise a genuine dispute with the DSEIS on a material issue of law or fact.[46]

First, Mr. Wexler fails to support the premise that FPL's effort to reduce the CCS salinity to 34 PSU is not working and is unlikely to work in the future.[47] As discussed supra Part III.C.3.a, where we rejected this identical premise, the DSEIS shows that (1) the targeted deadline for FPL to reach a CCS salinity level of 34 PSU is May 2021; (2) the NRC Staff independently assessed the reasonableness of the model on which that deadline is based; and (3) Joint Intervenors failed to show a genuine dispute of material fact with regard to that timeline or the reasonableness of the model on which the timeline is based. See supra note 31. Mr. Wexler likewise fails to provide support to show a genuine dispute of material fact regarding that timeline or the reasonableness of the model on which the timeline is based, rendering this aspect of Contention 9-E inadmissible pursuant to 10 C.F.R. § 2.309(f)(1)(v) and (vi).

The second premise on which Contention 9-E is based—i.e., the claim that FPL's effort to mitigate the hypersaline plume is not working and is unlikely to work in the future—similarly lacks support. Mr. Wexler asserts that his analysis using FPL's model "shows that without

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[46] In support of their challenge to the NRC Staff's conclusions regarding potential groundwater use conflicts for the Biscayne and Upper Floridan aquifers, Joint Intervenors broadly cite to Section IV.B of their motion, see Joint Intervenors' Motion for New Contentions at 52 n.205, and to page 2 of Mr. Wexler's Declaration, see id. at 52 nn.206 & 207. Those references describe concerns about groundwater modeling and the NRC Staff's analysis, but they fail to provide a credible factual roadmap showing that those concerns will cause the predicted impacts on groundwater use conflicts to be different from those stated in the DSEIS. This failure, standing alone, renders Contention 9-E inadmissible pursuant to 10 C.F.R. § 2.309(f)(1)(vi) for failing to show a genuine dispute of material fact.

[47] Mr. Wexler simply states that FPL "was unable to achieve freshening of the CCS . . . from November 2016 to May 2017, salinities in the CCS did not go down to 35 PSU (FPL 2017a), at the end of May 2017, average salinity concentrations in the . . . CCS were 64.9 PSU (FPL 2017b)." Wexler Decl. at 4. As we explained supra Part III.C.3.a, these statements do not demonstrate that FPL's freshening efforts are not working or that they are likely to fail. See supra notes 30–32 and accompanying text.

freshening the CCS, the recovery system will not be able to meet the target of retracting the hypersaline water." Wexler Decl. at 2. In other words, Mr. Wexler states that the second premise (i.e., that FPL's current plan to mitigate the hypersaline plume will not succeed) follows inexorably from the first premise (i.e., that FPL's current plan to reduce CCS salinity will not succeed). This is an example of heaping conjecture upon conjecture. As we have shown, the first premise lacks adequate support; it therefore follows that the second premise, to the extent it is grounded on the first premise, likewise lacks adequate support.

Notably, the second premise is identical to the premise Joint Intervenors advanced in support of Contention 8-E. See Joint Intervenors Motion for New Contentions at 48 (disputing that "[FPL's] recovery well system will be 'successful' in retracting the hypersaline plume before the end of the current license period"). In rejecting that premise in the context of Contention 8-E, we stated that the NRC Staff's conclusion was "based on its review of (1) FPL's groundwater modeling and modeling results; (2) the operation and efficacy of FPL's hypersaline groundwater recovery well system; (3) FPL's groundwater monitoring program; and (4) the regulatory enforcement and oversight of Florida and Miami-Dade County[.]" Supra Part III.E.1. We concluded that Joint Intervenors failed to identify a deficiency in the NRC Staff's review, and they failed to provide the necessary support to show a genuine dispute on a material issue of law or fact, as required by 10 C.F.R. § 2.309(f)(1)(v) and (vi). See id. The second aspect of Contention 9-E suffers from the same infirmities.[48]

Mr. Wexler nevertheless asserts that data from a "new, independently developed model" shows that "freshening of the CCS will be difficult to achieve with the volumes of water currently

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[48] Mr. Wexler also claims that "new water quality information" supports his views. See Wexler Decl. at 2. But, as the NRC Staff correctly states, see NRC Staff's Answer at 48, this so-called "new" information—i.e., two FPL reports issued in 2017—was considered by the NRC Staff in the DSEIS. See, e.g., DSEIS at 3-41, 3-42, 3-44 to 3-47, 3-49, 6-15. Similarly, the 2016 and 2018 Tetra Tech models cited by Mr. Wexler were likewise considered in the DSEIS. See id. at 3-73, 4-26, 6-31.

being used and the locations selected for adding the water." Wexler Decl. at 2. Even assuming arguendo that Mr. Wexler were correct that mitigation goals will be difficult to achieve under the current plan, that does not establish a genuine dispute of material fact with the DSEIS, because this concern fails to acknowledge the DSEIS's discussion that Florida regulatory authorities are actively engaged in the regulation and oversight of FPL's (1) reduction of CCS salinity; (2) mitigation of the hypersaline plume; (3) withdrawal of groundwater; and (4) contribution to groundwater use conflicts. See DSEIS at 4-28 to 4-33. Mr. Wexler provides no reason to conclude that Florida would refrain from modifying current requirements affecting the "volumes of water currently being used and the locations selected for adding the water[,]" Wexler Decl. at 2—if necessary—to achieve the desired water quality goals in a manner that does not contribute significantly to groundwater use conflicts. As the DSEIS states, "even if the groundwater remediation timeframe is extended or delayed, the modeling results and the safeguards imposed by [Florida] through permit conditions provide reasonable assurance that any impacts on groundwater resources and users would be mitigated, while producing beneficial effects on groundwater quality."[49] DSEIS at 4-30.

In short, Contention 9-E is not admissible because its lacks supporting information and it fails to establish a genuine dispute of material law or fact with the DSEIS, as required by 10 C.F.R. § 2.309(f)(1)(v) and (vi).

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[49] The water use permit issued to FPL by the South Florida Water Management District (SFWMD) for operation of the recovery well system bounds the total installed production capacity of the recovery wells. See DSEIS at 4-29. The permit also requires that FPL mitigate interference with existing legal uses of groundwater and mitigate harm to natural resources, possibly by reducing or otherwise altering groundwater withdrawals. See id. As necessary, SFWMD can order FPL to reduce withdrawals or undertake other mitigative measures. See id. at 4-32. Notably, the DSEIS states that "FPL does not anticipate the need to withdraw groundwater at a rate exceeding its current permits and/or authorizations during the [SLR] period (FPL 2018f)." Id. at 4-33. If such a need were to arise, FPL would be required to obtain approval from the responsible Florida regulatory authority. See Tr. at 464.

IV. CONCLUSION AND ORDER

For the foregoing reasons, we (1) deny Joint Intervenors' petition for rule waiver for Contention 7-E; and (2) deny Joint Intervenors' motion to admit newly proffered contentions, thereby terminating this proceeding at the Licensing Board level.

An appeal to the Commission may be filed in accordance with the provisions in 10 C.F.R. § 2.311(b).

It is so ORDERED.

THE ATOMIC SAFETY
AND LICENSING BOARD

/RA/

E. Roy Hawkens, Chairman
ADMINISTRATIVE JUDGE

/RA/

Dr. Sue H. Abreu
ADMINISTRATIVE JUDGE

/RA/

Dr. Michael F. Kennedy
ADMINISTRATIVE JUDGE

Rockville, Maryland
October 24, 2019

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
FLORIDA POWER & LIGHT COMPANY	)	Docket Nos. 50-250-SLR
	)	50-251-SLR
(Turkey Point Nuclear Generating Units 3 & 4)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing **Memorandum and Order (Denying Requests for Rule Waiver and Admission of Newly Proffered Contentions, and Terminating Proceeding) (LBP-19-08)** have been served upon the following persons by Electronic Information.

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[Original signed by Clara Sola]
Office of the Secretary of the Commission

Dated at Rockville, Maryland,
this 24th day of October 2019.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE COMMISSION

In the Matter of	)	Docket Nos. 50-250 & 50-251
FLORIDA POWER & LIGHT COMPANY	)	ASLBP No. 18-957-01-SLR-DB01
(Turkey Point Nuclear Generating Station, Unit Nos. 3 and 4)	)	November 18, 2019
(Subsequent License Renewal Application)	)	

FRIENDS OF THE EARTH'S, NATURAL RESOURCES DEFENSE COUNCIL'S, AND MIAMI WATERKEEPER'S PETITION FOR REVIEW OF THE ATOMIC SAFETY AND LICENSING BOARD'S RULING IN LBP-19-08

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November 18, 2019

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Pursuant to 10 C.F.R. § 2.341, Friends of the Earth, Natural Resources Defense Council, and Miami Waterkeeper (together "Petitioners") seek review of the Atomic Safety and Licensing Board's (Board) decision in LBP-19-08.[1] Respectfully, the Nuclear Regulatory Commission ("NRC" or "Commission") should reverse this decision and grant Petitioners a hearing on the merits.

I. PROCEDURAL BACKGROUND

On March 2019, the Nuclear Regulatory Commission Staff (NRC Staff or Staff) published the Draft Environmental Impact Statement (DSEIS) for Florida Power & Light Company's (Applicant) Subsequent License Renewal Application (SLRA).[2] On June 24, 2019, Petitioners timely proffered new Contentions based on the DSEIS[3] and petitioned for a rule waiver.[4] After the parties briefed the merits of the Contentions, the Board scheduled oral argument on the matter for September 9, 2019.[5] Following oral argument,[6] the Board denied

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[1] Memorandum and Order (Denying Requests for Rule Waiver and Admission of Newly Proffered Contentions, and Terminating Proceedings), LPB-19-08, __ NRC __ (Oct. 24, 2019) (slip op.) (hereinafter "Dismissal").
[2] NUREG-1437, Supp. 5, Second Renewal, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 5, Second Renewal, Regarding Subsequent License Renewal for Turkey Point Nuclear Generating Unit Nos. 3 and 4, Draft Report for Comment" (Mar. 2019) (ML19078A330) (hereinafter "DSEIS").
[3] [Petitioners'] Motion to Migrate Contentions & Admit New Contentions in Response to NRC Staff's [DSEIS] (June 24, 2019) and [Petitioners'] Amended Motion to Migrate Contentions & Admit New Contentions in Response to NRC Staff's [DSEIS] (June 28, 2019) (ML19179A316) (hereinafter "Motion").
[4] [Petitioners'] Petition for Waiver of 10 C.F.R. § 51.53(C)(3) and 51.71(D) and 10 C.F.R. Part 51, Subpart A, Appendix B (June 24, 2019) at 6 (unnumbered) (ML19175A311).
[5] Order Scheduling Oral Argument (Aug. 9, 2019) (ML19221B552) (hereinafter "Scheduling Order").
[6] Official Transcript of Proceedings, [Applicant] Turkey Point Nuclear Generating Units 3 and 4 (Sept. 9, 2019) (ML19254E569) (hereinafter "Tr.").

Petitioners' request for a rule waiver and ruled inadmissible each Contention, thereby terminating the proceeding.[7]

II. STANDARD OF REVIEW

"The Commission defers to a Board's rulings on standing and contention admissibility in the absence of clear error or abuse of discretion."[8] While the Commission's review of factual findings is deferential, it will correct findings when there is "strong reason to believe that a board has overlooked or misunderstood important evidence."[9] The Commission reviews legal questions "de novo."[10]

III. ARGUMENT

The Board arbitrarily overlooked, misunderstood, or refused to consider important information and applied incorrect legal standards in denying Petitioners' Contentions. Petitioners satisfied each of the NRC's requirements with respect to the six Contentions presented. Thus, the Board erroneously denied admission to the Contentions, and the Commission should reverse.[11]

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[7] Dismissal at 41.
[8] *Crow Butte Res., Inc.* (License Renewal for In Situ Leach Facility, Crawford, Nebraska), CLI-09-9, 69 NRC 331, 336 (2009).
[9] *Powertech (USA), Inc.* (Deqey-Burdock In Situ Uranium Recovery Facility), CLI-16-20, 84 NRC 219, 228 (2016).
[10] *Pa'ina Hawaii, LLC* (Materials License Application), CLI-10-18, 72 NRC 56, 73 (2010).
[11] Petitioners are not appealing the Board's decision as to Contention 1-E(b). While Petitioners believe the Board made clear errors in denying admission to this Contention, the Final Supplemental Environmental Impact Statement (FSEIS) addresses Petitioners concerns such that the FSEIS likely would moot this Contention regardless.

A. The Board Erred in Denying Contention 5-Eb.

Contention 5-Eb states that the DSEIS deficiently analyzed potential impacts of ammonia on threatened and endangered species and their critical habitat.[12] The Board's denial of Contention 5-Eb is in clear error and an abuse of discretion because it overlooked relevant evidence and instead relied on erroneous and immaterial evidence.

The Board rationalized that the DSEIS analyzed ammonia impacts based on which threatened and endangered species "might conceivably be exposed"[13] to ammonia but ignored Petitioners' evidence that the American crocodile might be exposed.[14] Petitioners provided evidence that (1) Turkey Point's cooling canal system (CCS) is a contributing factor to levels of ammonia above regulatory limits in multiple locations and (2) the American crocodile nests in the same location as those high levels of ammonia. Petitioners provided that the DSEIS acknowledged that there are levels of ammonia around Turkey Point above water quality standards and that there has been the suggestion of a statistically increasing trend of ammonia in the CCS.[15] Petitioners next pointed to a document cited by the DSEIS that included specific test

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[12] Motion at 21–25 and Reply Reply in Support of Motion to Migrate Contentions & Admit New Contentions in Response to NRC Staff's [DSEIS] (July 26, 2019) at 7–9 (ML19207C092) (hereinafter "Reply").
[13] Dismissal at 14.
[14] *See e.g.*, *id.* at 15 n.25 ("…because the ammonia concentration in the analyzed environments is less than the Miami-Dade water quality standard, the NRC Staff assumes that there would be no lethal effects or impairments to growth, survival, or reproduction of endangered or threatened species. [Petitioners] offer no facts or expert opinions that impugn the NRC Staff's assumption.").
[15] Reply at 7 n.31 citing DSEIS at 3-52 (citing Letter from W. Mayorga, DERM, to M. Raffenberg, FPL (July 10, 2018)) and Tr. at 339.

results of water quality showing high ammonia levels in specific locations.[16] Petitioners then showed how these specific locations of high ammonia are also documented nesting sites for the American crocodile.[17] Thus, Petitioners provided ample evidence that the American crocodile "might conceivably be exposed" to ammonia and that the DSEIS needed to consider it.

In attempting to reconcile why the DSEIS considered impacts of ammonia on the West Indian manatee and not the American crocodile, the Board explained that:

> [D]ifferent analyses for different species based on different circumstances do not perforce equate to inadequate analyses. Rather, case law supports the conclusion that the NRC Staff acts reasonably . . . in analyzing the impact of ammonia *in proportion* to its potential impacts on threatened and endangered species and their habitats.[18]

Petitioners do not contest this, and in fact in Contention 5-E(b) asked for impacts of ammonia to be analyzed in proportion to its potential impacts on specific species.[19] It is backwards then for the Board to fault Contention 5-E(b) because the so-called "sole basis" for the Contention is "that the DSEIS includes a more thorough analysis for the West Indian manatee than for other threatened and endangered species."[20] If the rule is that an issue should be analyzed in proportion to its potential impacts, then the DSEIS should include a more thorough analysis for whichever species are most likely to be impacted by ammonia—and there is

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[16] Tr. at 353 (describing document FPL-2017c, page 67, Table 6 title "Ammonia in Surface Waters" in which multiple lines between 99 and 110 documenting samples taken at locations TPS-WC7 and TPS-WC8 are high in ammonia and low in dissolved oxygen).
[17] Reply at 9 and Tr. at 353 (describing how the map in Figure 12 from the Biological Assessment at page 28 titled "Locations of Crocodile Nests in the Turkey Point Cooling Canal System" shows American crocodile nests in the same locations as water sample locations TPS-WC7 and TPS-WC8, which had the high ammonia levels).
[18] Dismissal at 15 (emphasis added).
[19] Reply at 9.
[20] Dismissal at 15.

significant evidence in the record that the American crocodile is more likely to be impacted by ammonia than the West Indian manatee. The Board explained that "the stagnant or dead-end canals where the elevated ammonia concentrations are located do not provide preferred habitat for manatees" and therefore there is a "very low likelihood of manatees being exposed to contaminants associated with the CCS, including ammonia. . . "[21] On the other hand, Petitioners offered all of the evidence above that there is a high likelihood of American crocodiles being exposed to ammonia because crocodiles nest in locations with high ammonia concentrations. The NRC Staff therefore did not act reasonably in its analysis of ammonia impacts on species because it failed to analyze the issue in proportion to the potential impacts.

Yet the Board ignored all of this evidence and instead focused on aspects of the DSEIS that are immaterial to the admissibility of Contention 5-Eb. The Board stated how the DSEIS generally discussed "the environment at the Turkey Point facility and the role ammonia might play in that environment,"[22] yet somehow the Board did not address any of the details Petitioners provided on ammonia levels above water quality standards in crocodile habitat. The Board also cited multiple parts of the DSEIS that do not even mention ammonia to support its conclusion that "the NRC Staff also analyzed the impact of the CCS, including its ammonia content."[23]

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[21] *Id.* at 14–15 (internal citations omitted).
[22] *Id.* at 12–14.
[23] *See id.* at 15.

The Board abused its discretion by overlooking relevant evidence Petitioners offered and instead basing its decision on erroneous and immaterial evidence. The Commission should reverse the Board's Order and admit Contention 5-Eb.

B. The Board Erred in Denying Contentions 6-E through 9-E.

In Contentions 6-E through 9-E, Petitioners argued that the DSEIS failed to take the "hard look" required by the National Environmental Policy Act (NEPA) at the environmental impacts of continuing to operate the CCS. The CCS is the source of a hypersaline groundwater plume that violates water quality standards beyond the plant's boundary.[24] State and county regulators therefore took enforcement actions to require Applicant to reduce the annual average salinity in the CCS to 34 practical salinity units (PSU) and retract the hypersaline plume within 10 years.[25] Thus, Applicant instituted a "freshening" plan to dilute the CCS by pumping 15 million gallons per day (mgd) of groundwater into the CCS. It designed this plan using a 2014 model that predicted salinity levels would reach 34 PSU within "less than a year" of commencing the project.[26] Applicant also instituted a plan to retract the hypersaline plume using a series of wells to extract the hypersaline plume water and inject it deep underground. Applicant

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[24] DSEIS at 3-67.
[25] *See* Florida Department of Environmental Protection, *Consent Order*, OGC File Number 16-0241 (June 20, 2016) (ML16216A216); Miami-Dade County, *Consent Agreement Concerning Water Quality Impacts Associated with the Cooling Canal System at Turkey Point Power Plant* (Oct. 6, 2015) (ML15286A366).
[26] Dismissal at 21 (citing DSEIS at 3-49).

developed this plan using a 2016 model, which assumed Applicant's "freshening" plan maintains CCS salinity at 34 PSU.[27]

Petitioners' contended the DSEIS erroneously relied on these unproven efforts to manage CCS salinity and retract the hypersaline plume in concluding that impacts will be "small" on nearby surface waters via the groundwater pathway (Contention 6-E), groundwater quality (Contention 7-E), groundwater use conflicts (Contention 8-E), and cumulative impacts on groundwater resources (Contention 9-E).[28] The Board rejected Contentions 6-E through 9-E in clear error because the Board overlooked, misunderstood, or ignored important information presented in Petitioners' Contentions and confirmed in these proceedings.

1. **The Board ignored Applicant's admission at oral argument that the 2014 model was based on "particularly wet" weather data and produced "skewed" results.**

The Board committed clear error because it overlooked, misunderstood, or ignored important information that established Petitioners' genuine dispute with the DSEIS conclusions on impacts from the CCS.[29] The DSEIS relied on Applicant's "freshening plan" for the CCS that

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[27] Decl. of E.J. Wexler in Support of [Petitioners'] (Jun. 28, 2019) (ML19179A314) at 4 (hereinafter "Wexler Dec."); Reply at 14–15; *see also*, Tr. at 430:12–18.

[28] *See, e.g.*, Motion at 32 n.144 (citing the NRC Staff's conclusions on impacts on adjacent water bodies via the groundwater pathway (DSEIS at 4-23), impacts on groundwater quality (DSEIS at 4-27), and cumulative impacts on groundwater resources (DSEIS at 4-117).

[29] *Gulf States Util. Co.* (River Bend Station, Unit 1), CLI-94-10, 40 NRC 43, 51 (1994) (quoting Final Rule, Rules of Practice for Domestic Licensing Proceedings – Procedural Changes in the Hearing Process, 54 Fed. Reg. 33,168, 33,171 (Aug. 11, 1989)); *see also La. Energy Servs., L.P.* (National Enrichment Facility), CLI-04-35, 60 NRC 619, 623 (2004); *USEC, Inc.* (American Centrifuge Plant), LBP-05-28, 62 NRC 585, 596-97 (2005); *Luminant Generation Co.* (Comanche Peak Nuclear Power Plant, Units 3 & 4), LBP-09-17, 70 NRC 311, 329 (2009).

is based on the 2014 model that predicted decreasing salinity levels in the CCS.[30] At oral argument, however, counsel for Applicant confirmed the 2014 model that predicted decreasing salinity levels in the CCS was unreliable because it was based on a "particularly wet" year of weather data that "skewed" its predictions.[31] Counsel "had to dispel any notion that that specific model, the 2014 one, really is still even relevant . . . the model has been subsequently updated and recalibrated."[32] Apparently, the "recalibrated" model "encompasses a much broader range of hydrologic conditions, including drier conditions."[33] These are the same less favorable climatic conditions referenced in the DSEIS that Petitioners pointed to in support of their Contentions.[34] Counsel also referenced Applicant's public comments on the DSEIS,[35] which explain:

> The updated modeling indicates a wider range of evaporative conditions exist, particularly during the dry seasons, which exceed 14 mgd and suggest that *when such drier conditions occur, more freshening water or longer timeframes will be needed* to offset the drought related evaporative losses from the CCS.[36]

Counsel's statements confirm: (1) the 2014 model was unreliable because it failed to account for less favorable climatic conditions in predicting how salinity levels will change in the

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[30] DSEIS at 3-49.
[31] Tr. at 428:8–15.
[32] Tr. at 429:4–7. Counsel also testified that Applicant included this information in its publicly available DSEIS comments. These comments, however, did not provide a copy, reference, or weblink to the "refined" model that would allow the Staff or the public an opportunity to review the model or its results. [Applicant's] Comments Regarding the Turkey Point Nuclear Generating Unit Nos. 3 and 4 Subsequent License Renewal Draft Supplement 5 Generic Environmental Impact Statement (May 20, 2019) (ML19141A047) (hereinafter "Applicant's Comments").
[33] Tr. at 428:16–18.
[34] Motion at 41.
[35] Tr. at 428:16–429:3 (referencing ML19141A047).
[36] Applicant's Comments (attachment at 9) (emphasis added). None of this information appears in the DSEIS despite its obvious importance. Nor was this refined model otherwise made available or referenced in this proceeding before oral argument.

CCS;[37] (2) the DSEIS conclusions on impacts from the CCS were based on this unreliable model that produced "skewed" results;[38] (3) the NRC Staff never took a "hard look" at the effect of less favorable climatic conditions on Applicant's CCS freshening plan;[39] and (4) Applicant's current plan will not succeed unless more favorable climatic conditions return for good.[40] Thus, the Board committed clear error in denying Contentions 6E through 9E by overlooking or ignoring Counsel's confirmation that DSEIS conclusions about impacts from Applicant's CCS were based on a flawed assessment of Applicant's freshening effort.

2. The Board arbitrarily disregarded Petitioners' expert reports and evidence of Applicant's failure to lower salinity in the CCS to 34 PSU.

Petitioners supported their Contentions with evidence from the DSEIS and expert reports, yet the Board arbitrarily disregarded this evidence to decide erroneously that Petitioners failed to support their contentions and establish a genuine dispute. As indicated in the DSEIS, instead of the CCS salinity levels reaching 34 PSU as predicted by the 2014 model, Applicant's freshening efforts yielded an average salinity concentration of 64.9 PSU.[41] The DSEIS discusses this discrepancy as follows: "Comparing CCS data and model results, the [Applicant's] modelers concluded that during this period (most of which occurred in the dry season), evaporation rates exceeded precipitations rates."[42] Therefore, "[t]he modelers anticipate that under more favorable

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[37] *See* Tr. at 428:16–18; 429:4–7.
[38] *See* Tr. at 428:8–15.
[39] *See* DSEIS at 3-49.
[40] *See* Applicant's Comments (attachment at 9).
[41] Dismissal at 21 (citing DSEIS at 3-49).
[42] *Id*.

climatic conditions (e.g., less severe dry seasons), the addition of . . . water should help to reduce CCS water salinities to 34 PSU."[43] In their Contentions, Petitioners argued the 2014 model was unreliable since there was "no effort to determine what climatic conditions would be necessary to achieve the salinity target, or whether these necessary climatic conditions will or are likely to exist during the subsequent license renewal period."[44]

Petitioners also offered the expert opinion of Dr. William Nuttle who, based on a recent study, opined that more favorable climatic conditions "are unlikely to occur."[45] Consistent with Dr. Nuttle's opinion, the DSEIS states that the average annual temperature in South Florida is projected to increase by up to 3.5 degrees by 2050.[46] Petitioners Contentions showed that in light of the climate disruption already being experienced in Florida, the DSEIS's failure to analyze less favorable climate conditions fails NEPA's "hard look" test.

The Board recognized these issues were in dispute and asked the parties to address several questions on these points during oral argument:

> In determining that CCS salinity levels should reach the required level of 34 [PSU] within or close to the designated [subsequent relicensing] period, the NRC Staff relied on "continued actions by [Applicant] . . . and regulatory oversight by Florida." DSEIS at 3-49. How is that determination reconciled with [Applicant's] freshening experience in

[43] *Id*.
[44] *See, e.g.*, Motion at 41.
[45] Reply at 17 (citing Motion at 28 and Expert Report of William Nuttle, Ph.D (Jun. 24, 2019) (ML19179A315) at 8).
[46] Scheduling Order at 4 (citing DSEIS at 4-117).

> 2017, which only reduce the PSU level to 64.9 rather than to the expected 35?[47]

The Board further asked what climatic assumptions were used in the freshening model, what steps the NRC Staff took to ensure assumptions were reasonable, and where one could look for the Staff's confirmation of the model's reasonableness in the DSEIS.[48]

Yet the Board ignored these issues and evidence to hold that Petitioners based Contentions 6-E through 9-E "on an erroneous view of the DSEIS's analysis."[49] First, the Board rejected Petitioners' characterization of Applicant's freshening efforts as "unsuccessful," finding instead that the DSEIS showed Applicant "achieved a measure of success."[50] But the Board's focus on how to characterize Applicant's freshening results does not cure those flaws that Petitioners identified in the DSEIS. Whether couched as "unsuccessful," a "measure of success," or perhaps as a "measure of failure," the facts still demonstrate a significant gap in the DSEIS analysis insofar as it fails to take the requisite "hard look" at the impact of less favorable climatic conditions. The Board's finding that Applicant was able to reduce salinity values compared to historically higher levels[51] does not address this gap either.

Next, the Board held that Applicant's inability to reduce salinity levels in the CCS as predicted does not "raise a credible inference that [Applicant's] model is fatally flawed or that its

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[47] Scheduling Order at 4.
[48] *Id*.
[49] Dismissal at 23.
[50] *Id.* at 22.
[51] *Id.* at 22 n.30.

freshening efforts are doomed to failure."[52] This conclusion is clearly erroneous. The Board found support for this conclusion in Applicant's Consent Order with Florida, which provides an extended deadline for Applicant to reach the 34 PSU target and that the NRC Staff "independent[ly] assess[ed] the reasonableness of the model underlying the freshening plan upon which that deadline is based."[53] However, Applicant's freshening model is no more or less reliable simply because Florida granted Applicant additional time to meet the 34 PSU target or because the Staff assessed the 2014 model's reasonableness. Neither of these facts reconcile the gap between the anticipated results of freshening the CCS within one year (34 PSU) and Applicant's actual experience (64.9 PSU).

The Board's reliance on the Staff's review of the 2014 model is similarly unavailing. The Board held a single "passage from the DSEIS supports the conclusion that the NRC Staff independently assessed the reasonableness of [Applicant's] modeling."[54] But according to this passage, the NRC Staff never reconciled the actual effect of less favorable climatic conditions (64.9 PSU) with the model-derived predictions (34 PSU).[55] The DSEIS passage does not mention or even reference the 2017 salinity results or climatic conditions; it only references information from 2012 and 2014, i.e., before Applicant commenced its "freshening" plan. Thus, the NRC Staff never considered the effect of less favorable climatic conditions on impacts from the CCS. Indeed, statements by Applicant's counsel at oral argument dispel any conceivable

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[52] *Id.* at 22.
[53] *Id.* at 22 n.31.
[54] *Id.* at 20.
[55] *See id.* at 21 (citing DSEIS at 3-49).

notion that the Board's findings are correct. The deadline in the Consent Order with Florida reflects the "refined" model described by Applicant's counsel, not the "skewed" 2014 version that Staff assessed in the DSEIS.[56]

Finally, the Board rejected the statement about "more favorable climatic conditions" as support for Petitioners' Contentions, holding that "the DSEIS does not indicate that [Applicant's 2014] model relies on more favorable climatic conditions as an essential assumption for achieving a CCS salinity of 34 PSU. . . ."[57] The 2014 model merely "discusses the observed effects of drier conditions, and the anticipated effects of less severe dry seasons, on the model predictions and results."[58] But these statements do not support the Board's conclusion; rather, they drive home Petitioners' point by recognizing two important facts: (1) that unfavorable climatic conditions affected the 2014 model predictions and results, and (2) that the DSEIS never reconciled the 2014 model in light of Applicant's 2017 salinity results.

In short, Petitioners presented more than sufficient evidence to show that a genuine dispute exists over the effectiveness of Applicant's remediation efforts for decreasing salinity in the CCS and associated impacts on the groundwater pathway (Contention 6-E), groundwater quality (Contention 7-E), groundwater use conflicts (Contention 8-E), and cumulative impacts on groundwater resources (Contention 9-E). NRC regulations therefore require that the Board

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[56] Tr. at 428:21–25.
[57] Dismissal at 22.
[58] *Id*. at 22–23.

authorize a hearing on these issues. The Board committed reversible error when it "overlooked or misunderstood" the important evidence provided in Petitioners' Contentions.

3. The Board ignored Petitioners' evidence of significant flaws in NRC Staff's analysis of Applicant's groundwater remediation efforts.

The Board erroneously rejected Petitioners' Contentions related to Applicant's effort to retract the hypersaline plume, which stretches beyond Turkey Point and is harming ground and surfacewater resources in south Florida. The Board claimed that Petitioners failed to point to specific evidence and therefore offered no support for the Contentions.[59] In fact, Petitioners presented substantial evidence, which the Board overlooked, ignored, or refused to consider. While the Board recognized Petitioners' Motion included a supposedly "lengthy" five-page section of expert opinions and reports, it held (incorrectly) that this information failed to satisfy the NRC's admissibility standards.[60] Those standards require "'a concise statement of the alleged facts or expert opinions' that support the contention, along with 'references to the specific sources and documents.'"[61] The Board erred because this five-page section of the Motion contained *exactly* what the rules require. The section includes numbered headings for each of Petitioners' proffered experts. Under each experts' heading, there is a bulleted list of their opinions. Each bulleted expert opinion in turn cites specific pages of that expert's report where

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[59] *Id.* at 23.
[60] *Id.* at 32 n.41.
[61] *Id.*

further support for the opinion can be found.[62]The Board's decision to ignore this evidence that Petitioners presented was an abuse of discretion.

This five-page section included the expert opinion of Mr. E.J. Wexler with corresponding references to his report. Mr. Wexler, who reviewed Applicant's efforts to retract the hypersaline plume, identified "serious flaws" in Applicant's modeling that were "especially critical" in light of Applicant's failure to reduce salinity levels to 34 PSU as predicted.[63] In particular, Applicant's modeling "assumed that the CCS would be maintained at 34 PSU for the duration of the recovery period,"[64] a fact confirmed at oral argument.[65] Since CCS salinity is the "key driver" for Applicant's remediation of the hypersaline plume, flaws identified in Applicant's freshening model carry over to Applicant's predictions for retracting the hypersaline plume. Mr. Wexler then ran the same 2016 plume retraction model assuming a salinity level of 60 PSU (4.9 PSU less than the 2017 observed levels).[66] The results showed that after ten years of pumping, the hypersaline plume would continue to extend more than two miles (12,000 feet) west of the CCS boundary.[67] Mr. Wexler also ran Applicant's updated versions of the 2016 model, which

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[62] Motion at 25–31.
[63] *Id.* at 28.
[64] Wexler Decl. at 2.
[65] Tr. 421:7–11 (Applicant's counsel stating that "the 3D solute transport model, that's the groundwater remediation model, essentially does assume a salinity of 34 PSU").
[66] Wexler Decl. at 2–3.
[67] *Id.* at 5, Figure 2.

demonstrated that "meeting the 2016 order with [the State] is not achievable with the number of wells and pumping volumes proposed."[68]

Mr. Wexler's opinions and underlying report, which the Board improperly ignored, provided the necessary support to show the existence of a genuine issue of material fact for Contentions 6E through 9E. As the Board recognized, the "NRC Staff concluded that [Applicant's] groundwater remediation efforts would be successful" based on Staff's mere "review of (1) [Applicant's] groundwater modeling and modeling results; (2) the operation and efficacy of [Applicant's] hypersaline groundwater recovery well system; (3) [Applicant's] groundwater monitoring program; and (4) the regulatory enforcement and oversight of Florida and Miami-Dade County."[69] Mr. Wexler demonstrated that the first three aspects of the NRC Staff's review were seriously flawed and that futher inquiry in depth is warranted. The Board's dismissal of this information is an abuse of discretion which the Commission should reverse.

4. The Board committed reversible error to the extent it relied on the existence of state and county enforcement and oversight.

The only remaining basis for the DSEIS's conclusions on "small" impacts from the CCS was the "fundamental fact—relied upon by the Staff's DSEIS"—that the state and county will ensure Applicant's remediation efforts are successful.[70] To rely on a measure of success that is not based on the model predictions or actual observations, but on the existence of agreements

[68] Motion at 28–29 (citing Wexler Decl. at 5).
[69] Dismissal at 34.
[70] NRC Staff's Answer to Joint Petitioners' (1) Amended Motion to Migrate or Amend Contentions 1-E and 5-E and to Admit Four New Contentions, and (2) Petition for Waiver (July 19, 2019) (ML19200A300) at 49.

with the state and county that specify compliance at some point in the future does not satisfy NEPA.[71] The DSEIS only offered rank speculation that a revised strategy would succeed if Applicant's current plans fail. Rather than admit a genuine dispute as to the effectiveness of Applicant's strategy, the NRC Staff assumed some other unspecified "revised" strategy would achieve what the current strategy does not. This is magical thinking as shown by the Board's reliance on a lone statement in the DSEIS stating "that if [Applicant] fails to reach an annual average salinity of 34 PSU or lower within four years . . . the Consent Order with Florida requires [Applicant] to submit a plan detailing additional mitigation measures, and a revised timeframe for achieving the salinity target."[72] While the Consent Order provides Applicant an opportunity to revise its current salinity-related plans, the future opportunity to correct problems with the existing plan—like failing to address less favorable climatic conditions—does not fill the void today in the DSEIS's analyses.

In Contentions 6-E through 9-E, Petitioners also contended that reliance on state and county oversight was misplaced for another reason. As explained by Petitioners' expert Dr. Nuttle, there is an ongoing inter-agency dispute between Florida and Miami Dade County.[73] The dispute centers on Florida's amendment to Applicant's Everglades Mitigation Bank Phase II Permit[74] and its resulting "material and significant changes to the hydrology of the Turkey Point

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[71] *Sierra Club v. Fed. Energy Regulatory Comm'n*, 867 F.3d 1357, 1375 (D.C. Cir. 2017).
[72] Dismissal at 21–22.
[73] Reply at 18.
[74] Motion at 26.

region."[75] Miami Dade County challenged the permit modification arguing it "may exacerbate the existing water quality violations that [Applicant] is otherwise working to abate and remediate, thus hindering the progress of those efforts and harming [nearby] wetlands. . . ."[76] Dr. Nuttle opined that an ongoing dispute between the two agencies responsible for overseeing Applicant's salinity management "is evidence that achieving compliance with requirements for remediation . . . does not reliably predict future compliance with state and local water quality requirements."[77] This evidence and testimony demonstrated that "the NRC cannot simply rely on a presumption of compliance when the regulating entities are litigating whether compliance with both of their requirements is even possible."[78] Not only is compliance with the Agreements no guarantee of "small" impacts, compliance with both Agreements may not be possible.

The Board misconstrued Petitioners' argument on this point. The Board faulted Petitioners for claiming "NEPA proscribes the NRC Staff from considering enforcement requirements and oversight activities . . . when preparing the DSEIS."[79] Petitioners never argued that NEPA "proscribes" consideration of regulatory oversight; but it does proscribe speculative reliance on the existence of oversight by another agency as a substitute for a proper NEPA analysis. The D.C. Circuit rejected this kind of blind reliance on other agencies as a substitute for

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[75] *Id.* at 28.
[76] *Id.* at 27.
[77] *Id.* at 28.
[78] Reply at 25.
[79] Dismissal at 24.

a proper NEPA analysis.[80] In sum, there is no basis to conclude the existence of oversight by state and county regulators will result in "small" impacts. Any reliance by the Board on such speculation is clearly erroneous.

C. The Board Erred in its Ruling Regarding Contention 7-E's Waiver.

Petitioners ordinarily must obtain a waiver from the Commission to challenge an NRC environmental impact statement's review of issues that were analyzed in a generic environmental impact statement (GEIS). But neither the Board nor the Commission has ever held that a waiver is required to challenge the site-specific review of environmental impacts of a Category 1 issue that NRC Staff conducted on its own accord.

Here, the Staff noted that:

> These aspects of [CCS] operations and their effects on groundwater quality were not considered in the GEIS as part of the technical basis for the Category 1 issue, "Groundwater quality degradation (plants with cooling ponds in salt marshes)." The NRC staff has determined that this information is both new and significant.[81]

Following its site-specific review of this normally Category 1 issue, Staff found that the groundwater quality impacts at Turkey Point are currently "moderate" whereas the GEIS found those impacts would be "small."[82] The Board overlooked that prior case law only prohibits "any contention on a 'category one' issue [that] amounts to a challenge to our regulation that bars

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[80] *Sierra Club*, 867 F.3d at 1375.
[81] DSEIS at 4-27.
[82] *Id.*

challenges to *generic environmental findings*."[83] Because Staff applied site-specific information to an ordinarily Category 1 issue and found a different impact than that in the GEIS, Petitioners are not challenging a generic environmental finding. Instead, they are challenging the Staff's new, site-specific finding. Thus, the Board erred in concluding that Contention 7-E, challenging Staff's new analysis, required a waiver.

In the alternative, the Board erred in concluding Petitioners failed to satisfy the rule waiver criteria. If Petitioners were required to request a waiver for Contention 7-E, Petitioners satisfied the four-factor *Millstone* test used to resolve waiver petitions.[84] The Board denied Petitioners' waiver request based on its conclusion that Petitioners had failed to satisfy the first *Millstone* factor—that the rule's strict application would not serve the purposes for which it was adopted.[85] However, the Board committed clear legal error in its application of the *Millstone* test.

Petitioners did not argue that any new information will always satisfy factor #1, as the Board stated.[86] Rather, Petitioners argued that new information *identified and evaluated for the*

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[83] *Entergy Nuclear Vt. Yankee, LLC and Entergy Nuclear Operations, Inc.* (Vermont Yankee Nuclear Power Station), *Entergy Nuclear Generation Co. and Entergy Nuclear Operations, Inc.* (Pilgrim Nuclear Power Station), CLI-07-3, 65 NRC 13, 20 (2007) (emphasis added).
[84] The *Millstone* test says that to obtain a rule waiver, Petitioners must show: (1) the rule's strict application would not serve the purposes for which it was adopted; (2) special circumstances exist that were not considered, either explicitly or by necessary implication, in the rulemaking proceeding leading to the rule sought to be waived; (3) those circumstances are unique to the facility rather than common to a large class of facilities; and (4) waiver of the regulation is necessary to reach a significant safety [or environmental] problem. *Dominion Nuclear Connecticut, Inc.* (Millstone Nuclear Power Station, Units 2 and 3), CLI-05-24, 62 NRC 551, 559-60 (2005).
[85] Dismissal at 28.
[86] *Id*. at 29.

first time in a DSEIS will satisfy factor #1.[87] The Board explained that the Commission's designation of an issue as a Category 1 issue reflects the Commission's expectations that its NEPA obligations have been satisfied by the environmental analysis in the GEIS. We agree. That means that when the NRC Staff look at new information on a Category 1 issue in a DSEIS, it is an acknowledgement that in this instance the division of issues as Category 1 and 2 will not serve the purpose for which the rule was adopted and thus needs to be waived.

The Board also clearly erred in depicting and applying the rule in both too large and too narrow a fashion. The Board too broadly stated the rule that "a petitioner must show that new and significant information, unique to a particular plant, exists" in order to waive the specific NRC regulations at issue in Petitioners' waiver.[88] This is the overarching rule to satisfy the requirements of a waiver petition, not the rule to meet factor #1, as the Board depicted it. The Board's depiction was erroneous and the Board provided no basis for its reading of the requirements that Petitioners must meet under factor #1.

The Board then focused the discussion of the rule's purpose too narrowly on why the Commission designated the issue as a Category 1 issue. The Board focused on the fact that the Category 1 impact is small. However, the purpose of the rule is broader than just that a single significance level can be assigned. Rather, an issue is Category 1 if (1) it applies to all plants *and* (2) site-specific mitigation measures will be warrantless. Issues are Category 2 if they cannot

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[87] *See* [Petitioners'] Petition for Waiver of 10 C.F.R. § 51.53(C)(3) and 51.71(D) and 10 C.F.R. Part 51, Subpart A, Appendix B (June 24, 2019) (ML19175A311) at 6 (unnumbered).
[88] Dismissal at 29.

meet one or more of the Category 1 criteria, "and therefore, additional plant-specific review is required."[89] The Board thus focused on only one of the criteria that makes an issue Category 1—the significance level—and dismissed the second criteria regarding site-specific measures. The Board erroneously applied the *Millstone* test. The Commission should reverse and grant the waiver.

IV. THE COMMISSION SHOULD GRANT THIS PETITION FOR REVIEW

The Commission considers several factors in determining whether to grant a petition for review.[90] Here, the Petition identifies findings of fact that are "clearly erroneous," "substantial and important questions of law, policy, or discretion," and "public interest" considerations.[91]

First, whether an applicant (and the NRC) can rely on compliance with state and county oversight in the evaluation of cumulative impacts raises a substantial and important questions of law, policy, or discretion. As Applicant observed elsewhere, this legal issue has broad significance in NRC proceedings.[92] Second, several Contentions raise substantial and important questions regarding the need to analyze changing climatic conditions in subsequent license renewal proceedings.

Last, granting this Petition is in the public interest. The Turkey Point plant is located adjacent to Biscayne Bay in Southeast Florida. It is also the only nuclear power plant that uses a

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[89] 10 C.F.R. Pt. 51, Subpt. A, App. B.
[90] 10 C.F.R. § 2.341(b)(4).
[91] *Id*. § 2.341(b)(4)(i), (iii), (v).
[92] [Applicant's] Answer to [Petitioners'] Petition for Waiver of Certain 10 C.F.R. Part 51 Regulations (July 19, 2019) at 16 (ML19200A298).

5,900-acre CCS as the ultimate heat sink for its operations, which is the source of a hypersaline plume that is harming groundwater and surface water resources in a region where water resources are already stressed. It is in the public's interest to ensure the NRC makes an informed decision about extending Applicant's license until 2053 when climatic conditions will be markedly worse than today. With respect, that analysis is lacking and there appears to be no interest in taking a hard look at the reasonably foreseeable impacts of operating Units 3 and 4 when the affected environment will be more stressed due to increased temperatures and higher sea levels. Granting this Petition and giving Petitioners an opportunity to present their case at a hearing would only further the public's interest, particularly when the license renewal will not take effect for another 13 years.

V. CONCLUSION

The Commission should remedy these clear errors in material facts and departures from governing precedents and established law, which raise substantial and important questions of law and policy warranting review.[93]

[93] *See* 10 C.F.R. § 2.341(b)(4).

Respectfully submitted,

Executed in Accord with 10 C.F.R. § 2.304(d)
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November 18, 2019

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE COMMISSION

In the Matter of	)	Docket Nos. 50-250 & 50-251
FLORIDA POWER & LIGHT COMPANY	)	ASLBP No. 18-957-01-SLR-DB01
(Turkey Point Nuclear Generating Station, Unit Nos. 3 and 4)	)	November 18, 2019
(Subsequent License Renewal Application)	)	

CERTIFICATE OF SERVICE

Pursuant to 10 C.F.R. § 2.305, I certify that, on this date, copies of the foregoing "Friends of the Earth's, Natural Resources Defense Council's, and Miami Waterkeeper's Petition for Review of the Atomic Safety And Licensing Board's Ruling in LBP-19-08" were served by Electronic Information Exchange (the NRC's E-Filing System) to all parties of record in the above-captioned docket.

/s/ Ken Rumelt
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Counsel for Friends of the Earth

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 4, 2019

Mr. Mano Nazar
President, Nuclear Division
and Chief Nuclear Officer
Florida Power and Light Company
700 Universe Blvd
Mail Stop EX/JB
Juno Beach, FL 33408

SUBJECT: ISSUANCE OF SUBSEQUENT RENEWED FACILITY OPERATING LICENSE NOS. DPR-31 AND DPR-41 FOR TURKEY POINT NUCLEAR GENERATING UNIT NOS. 3 AND 4 (EPID L-2018-RNW-0002)

Dear Mr. Nazar:

The U.S. Nuclear Regulatory Commission (NRC) has issued Subsequent Renewed Facility Operating License Nos. DPR-31 and DPR-41 to Florida Power & Light Company (FPL), for Turkey Point Nuclear Generating Unit Nos. 3 and 4 (Turkey Point). The NRC issued the subsequent renewed facility operating licenses upon completion of the NRC staff's review of your application dated January 30, 2018, as supplemented by letters submitted to the NRC through April 10, 2018.

Subsequent Renewed Facility Operating License Nos. DPR-31 and DPR-41 for Units 3 and 4 expire at midnight on July 19, 2052, and April 10, 2053, respectively. As you are aware, all adjudicatory matters before the Atomic Safety and Licensing Board (Board) regarding the Turkey Point subsequent license renewal application have been resolved with the Board's issuance of its decision in LBP-19-8, and adjudicatory proceedings before the Board have terminated. While appeals of the Board's decisions are currently pending before the Commission, the NRC staff has determined that issuance of the subsequent renewed licenses prior to Commission action on those appeals would not foreclose or prejudice any action by the Commission and the subsequent renewed licenses may therefore be issued.

Enclosure 1 to this letter contains Subsequent Renewed Facility Operating License No. DPR-31 for Turkey Point Unit 3.

Enclosure 2 contains Subsequent Renewed Facility Operating License No. DPR-41 for Turkey Point Unit 4.

Enclosure 3 contains the following appendices related to Turkey Point Units 3 and 4:

- Appendix A, "Technical Specifications"
- Appendix B, "Environmental Protection Plan"

Enclosure 4 contains the Record of Decision for Turkey Point.

Enclosure 5 is a draft copy of the related *Federal Register* notice of issuance of the subsequent renewed licenses as sent to the Office of the Federal Register for publication.

The technical basis for issuing the subsequent renewed facility operating licenses for Turkey Point is set forth in the NRC staff's "Safety Evaluation Report Related to the Subsequent License Renewal of Turkey Point Generating Units 3 and 4," dated July 22, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19191A057). The results of the NRC staff's environmental review related to the issuance of the subsequent renewed licenses are summarized in the record of decision, which is provided as Enclosure 4 to this letter, and are provided in detail in NUREG-1437, Supplement 5, Second Renewal, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 5, Second Renewal, Regarding Subsequent License Renewal for Turkey Point Nuclear Generating Unit Nos. 3 and 4, Final Report," dated October 2019 (ADAMS Accession No. ML19290H346).

No technical changes were made to the Technical Specifications as a result of this subsequent license renewal.

A new section, Section 2.1, "Endangered Species Act," was added to Appendix B, "Environmental Plan." Section 2.1 discusses the Biological Opinion issued by the Fish and Wildlife Service (FWS) that includes an Incidental Take Statement pertaining to the American crocodile (*Crocodylus acutus*) and eastern indigo snake (*Drymarchon couperi*). The Biological Opinion includes a Reasonable and Prudent Measure that the FWS determined to be necessary and appropriate to reduce take and to minimize the direct and indirect effects on listed species. The Terms and Conditions that implement the Reasonable and Prudent Measure are nondiscretionary. The currently applicable Biological Opinion concludes that continued operation of Turkey Point Nuclear Generating Unit Nos. 3 and 4, as a result of the subsequent license renewal, is not likely to jeopardize the continued existence of the listed species or to adversely affect the designated critical habitat of those species. FPL is required to adhere to the requirements of the Incidental Take Statement in the Biological Opinion. Future changes to the Biological Opinion, including the Incidental Take Statement, Reasonable and Prudent Measures, and Terms and Conditions contained therein, must be preceded by consultation between the NRC, as the authorizing agency, and the FWS.

If you have any questions regarding this matter, please feel free to contact me by phone at 301-415-6223 or by e-mail at David.Drucker@nrc.gov.

Sincerely,

/RA/

David Drucker, Senior Project Manager
License Renewal Projects Branch
Division of New and Renewed Licenses
Office of Nuclear Reactor Regulation

Docket Nos. 50-250 and 50-251

Enclosures:
As stated

cc: Listserv

UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT

FRIENDS OF THE EARTH, NATURAL RESOURCES DEFENSE COUNCIL, INC., and MIAMI WATERKEEPER Petitioners, v. UNITED STATES NUCLEAR REGULATORY COMMISSION and UNITED STATES OF AMERICA, Respondents.	No._20-1026

DECLARATION OF GINA TRUJILLO
DIRECTOR OF MEMBERSHIP
NATURAL RESOURCES DEFENSE COUNCIL

I, Gina Trujillo, declare as follows:

1. I am the director of membership at the Natural Resources Defense Council ("NRDC"). I have been the director of membership since January 1, 2015. I have worked in the membership department of NRDC for more than 24 years

2. My duties include supervising the preparation of materials that NRDC distributes to members and prospective members. Those materials describe NRDC and identify its mission.

3. NRDC is a membership organization incorporated under the laws of the State of New York. It is recognized as a not-for-profit corporation under section 501(c)(3) of the United States Internal Revenue Code.

4. NRDC currently has approximately 375,200 members. There are NRDC members residing in each of the fifty United States and in the District of Columbia. NRDC has 14,595 members in Florida. There are at least 1,477 members living within 50 miles of the Turkey Point Nuclear Generating Stations and at least 54 members live within 10 miles of the facility.

5. NRDC's mission statement declares that "The Natural Resources Defense Council's purpose is to safeguard the Earth: its people, its plants and animals, and the natural systems on which all life depends." Furthermore, NRDC "strive[s] to protect nature in ways that advance the long-term welfare of present and future generations," and "work[s] to foster the fundamental right of all people to have a voice in decisions that affect their environment."

6. Since its inception in 1970, NRDC has, as one of its organizational goals, sought to improve the environmental, health, and safety conditions at the nuclear facilities operated by the Department of Energy and the civil nuclear facilities licensed by the Nuclear Regulatory Commission and their predecessor agencies. To that end, NRDC utilizes its institutional resources (such as its capacities for legislative advocacy, public outreach and education, and litigation) to minimize the risks that nuclear facilities pose to its members and to the general public.

I declare under penalty of perjury that the foregoing is true and correct, to the best of my knowledge, information, and belief.

Dated: 3/3/20

Gina Trujillo

UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT

FRIENDS OF THE EARTH, NATURAL)
RESOURCES DEFENSE COUNCIL, INC.,)
and MIAMI WATERKEEPER)
)
Petitioners,) No._20-1026
)
v.)
)
UNITED STATES NUCLEAR)
REGULATORY COMMISSION and)
UNITED STATES OF AMERICA,)
)
Respondents.)
)

DECLARATION OF PHILIP STODDARD, PH.D.

I, Phillip Stoddard, declare as follows:

1. I make this declaration of my own personal knowledge. If called to testify as a witness, I could and would testify competently regarding its contents.

2. I am a current member of the Natural Resources Defense Council (NRDC). I have been a member since 1993. I joined NRDC because I care about the environment and believe that it is not being adequately protected. In general, I am worried about overexploitation of natural resources, climate change and sea level rise, contamination of air, water, soil and food, and the consequent potential impacts on human health and on the natural world. In particular, one of the reasons I have contributed to the NRDC was because of my concerns about

nuclear energy and its attendant risks following years of studying the operations at the Turkey Point Nuclear Generating Stations, and the special risks to mankind and the natural world posed by commercial operation of nuclear plants in a hurricane zone subject to storm surge.

3. I live at 6820 SW 64th Court, South Miami, Florida. I have lived at this address for about fifteen years.

4. My home is approximately 18 miles from the Florida Power & Light (FPL), Turkey Point Generating Station (TPGS), Units 3 & 4 in Homestead, Florida. I am aware that TPGS nuclear facility is seeking to have its operating license renewed for another 20 years by the Nuclear Regulatory Commission (NRC).

5. I used to be a "fan" of nuclear power because of its relatively low carbon footprint. Then I began looking into the safety record and environmental conditions at Turkey Point. As I studied the plant and its safety plan, I came to recognize greater hazards and environmental costs than had been made public. I was elected Mayor for the City of South Miami, Florida, in part because of my familiarity with these issues. My participation in public discussion of these issues has spanned nearly a decade. In the course of this participation, I physically toured the TPGS facility with FPL staff following the Fukushima accident, as part of FPL's program to assure elected officials that their own nuclear operation was

safe. During the proposed licensing of planned Units 6 & 7, I reviewed licensing documents and other material related to safety issues and severe accident risks posed by the TPGS facility, and I consulted with experts in nuclear safety and risk assessment concerning the risks of operation of the reactors. My particular areas of special concern are (i) vulnerability of the nuclear fuel and spent fuel containment to storm surge, (ii) environmental problems surrounding the use of cooling canals, and (iii) the extreme difficulty of evacuating southern Miami-Dade County quickly in the event of an accidental radiation release.

6. I remain unconvinced that the TPGS facility is as safe as it needs to be to operate adjacent to an urban area, subject as it is to sea level rise and hurricane-driven storm surge. I am particularly concerned about lack of careful analysis of vulnerability to storm surge of cooling systems and stored fuel. I remain concerned with the risks to continued nuclear reactor operations resulting from parts failure and human error. I am concerned about embrittlement of the reactor vessel, designed for 40 years' operation, now proposed for 80 years, with no verification that a doubling of neutron bombardment will not create special vulnerability to accidental sudden cooling. I am not convinced that the NRC has adequately assessed the full-scale, long-term consequences of continued operations of the cooling canals, a poorly conceived cooling system design that is unique to this site of porous geology. Saline leakage, overheating, evaporative

concentration of salt, and storm washout are harmful to the southern reaches of the Biscayne Aquifer, Biscayne Bay, and the Southeast Coastal Everglades. The accident at Three Mile Island showed me the vulnerability of domestic nuclear plants to human error, to which TPGS has repeatedly proven prone. The disaster at the Fukushima-Daichi Nuclear Power Plant in Japan caused me increased concern about the unique vulnerabilities of nuclear power reactors to rare external events – here, the NRC's probabilistic analysis is cold comfort, since infinity (the cost to me of an accident that leaves South Miami-Dade uninhabitable) divided by ten to the 4th power (the estimated likelihood of a particular accident) is still infinity. I sincerely question whether TPGS, in its current configuration, enjoys the full benefit of modern design knowledge needed to ensure that no harm to humans or the environment could come from the extended operation of its nuclear reactors.

7. The region where I live, Southeastern Miami-Dade County, has become far more populated and developed since the original licensing of the TPGS. The population of Miami-Dade County has more than doubled, with most of the growth concentrated in the south end within 15 miles of Turkey Point. The population has been increasing by an average 1.5%. If this rate continues the population will increase by another two thirds by the end of the proposed relicensing period, 2052. By 2112, the end of the decommissioning period, the

low elevation neighborhoods nearby will likely be depopulating because of sea level rise.

Recognizing the growing impossibility of timely evacuation of our greatly expanded population on a limited highway network, the current regional plan for a radiation emergency calls for "sheltering in place." Under this plan, residents are to stay in their (powerless) dwellings, taping over the A/C vents and door seams to prevent radiation exposure. The limited ability of people to survive in a closed-up building in South Florida, in the summer heat, without air conditioning, seems not to have entered the calculus. This planning oversight might reasonably be viewed as criminal negligence in the aftermath of an actual emergency.

8. FPL's Turkey Point operation is misusing our limited supply of freshwater. Southeast Florida requires a freshwater head to hold out the saltwater that would otherwise infiltrate our groundwater and exacerbate hypersalinity. The need to conserve these local freshwater sources is urgent. Climate change is already causing local sea levels to rise, increasing saltwater pressure on the aquifer. The local population continues to grow, increasing freshwater demand. By using cooing canals instead of cooling towers as the ultimate heat sink for the nuclear plants at Turkey Point, FPL increases evaporative loss beyond what is necessary. In using freshwater for what is likely to be an unsuccessful attempt to mitigate the hypersaline plume generated by canal evaporation, FPL is misusing

the limited freshwater supply to attempt to address a problem of their own making. While my drinking water is not supplied directly from the well fields most at risk, water is pumpable and therefore fungible. As the regional supply is depleted, the County must make up the shortfall, at considerable expense to the consumer, through desalination. In the height of irony, desalination requires vastly more electricity; FPL is raising demand for electricity by wasting water, and wasting water by meeting this demand. We have to maintain our regional freshwater head as long as we can, and FPL's plan to keep Turkey Point cool and its failing attempt to mitigate the hypersaline plume is raising the cost of domestic drinking water and shortening the period before seawater infiltrates our aquifer.

9. Moreover, because my home is well within the 50-mile emergency planning zone for the ingestion pathway, I am concerned that an accident at the TPGS may result in dangerous airborne levels of radioiodines, with subsequent elevations of radiation-induced thyroid cancers as reported near Chernobyl and Three Mile Island. Prevailing winds at TPGS are often in the direction of inhabited areas. No realistic plan exists to distribute potassium iodide prophylaxis to the vulnerable population before airborne exposure to radioiodines.

10. I know that the NRC must undertake an environmental review when it grants relicensing permits to nuclear power plants such as the TPGS. However, I am aware that there are a number of issues that as part of this relicensing have

not been adequately or accurately analyzed. Examples include, but are not limited to (i) sea level rise, (ii) microcystins produced by cyanobacterial blooms in the cooling canals, (iii) risks from reactor embrittlement, and (iv) vulnerability to backup power, cooling systems, and spent fuel in dry casks from storm surge (including surge-propelled marine vessels). Nor has FPL provided sufficient analysis of the potential ways to mitigate the consequences of the continued operations.

11. The failure to require updated studies and plans concerns me. Sea level rise was not even on the radar when the plants were initially licensed. I want to know that if the reactors are allowed to operate for 80 years (an additional 20 years beyond the already once-extended timeframe of 40 to 60 years) that the extended operating life is supported by reliable and accurate prospective analyses and realistic mitigation strategies, sufficient to effectively eliminate environmental and safety risks or impacts.

12. I would certainly pay close attention if the NRC were to analyze carefully the significant issues of sea level rise, environmental impacts of cooling systems, changes in population safety issues, and effective mitigation measures. A clear analysis would help me feel safer and better informed of the risks my family and neighbors face as a nearby residents. Such analysis would also help me determine what steps I need to take now to protect myself and others in the event

for decades, or ever for some of the issues, I remain deeply concerned.

13. The NRC has a duty to protect the American people, not to protect the nuclear industry. It also has a duty to keep us informed about the risks inherent in any nuclear energy plant now proposed to operate for double its design life, including any risk related to aging plants, aging materials, vulnerable fuel storage, or emerging risks from changes in climate and sea level.

14. I support NRDC's intervention in this case and authorize them to act on my behalf because I believe, with their participation, the Nuclear Regulatory Commission will be better positioned to fully review the possible impacts of the applicant's proposed relicensing for an additional 20 years, and, based on NRDC's and its experts' information, may address concerns and mitigate impacts to human health, as well as our water, land, and other resources, in the event of continued operation of the TPGS.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge, information, and belief and that this declaration was executed on March 4, 2020 in South Miami, Florida.

Philip K Stoddard

Philip K. Stoddard, Ph.D.

UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT

FRIENDS OF THE EARTH, NATURAL RESOURCES DEFENSE COUNCIL, INC., and MIAMI WATERKEEPER Petitioners, v. UNITED STATES NUCLEAR REGULATORY COMMISSION and UNITED STATES OF AMERICA, Respondents.	)	No. 20-1026

DECLARATION OF ALAN THOMAS

I, Alan Thomas, declare as follows:

1. I make this declaration of my own personal knowledge. If called to testify as a witness, I could and would testify competently regarding its contents.

2. I am a current member of the Natural Resources Defense Council (NRDC). I joined NRDC because I am concerned about the environment, as I think anyone who lives on earth should be in this day-and-age.

3. I live at 11271 SW 175th Street, Miami, Florida. I have lived in Miami since 1968.

4. My home is approximately 14 miles from the Florida Power & Light (FPL), Turkey Point Generating Station (TPGS), Units 3 & 4 in Homestead,

Florida. I am aware that TPGS nuclear facility is seeking to have its operating license renewed for another 20 years by the Nuclear Regulatory Commission (NRC). I do not, however, understand why FPL is trying to keep TPGS open through the 2050's. The facility was never designed to be open this long already so it's already past its active lifecycle. It seems short-sighed and dangerous to me to keep such a facility open. I address some of my primary concerns below.

5. One of the scariest moments in my life was in September 2017 when hurricane Irma just missed hitting TPGS. During hurricanes, I usually hunker down in my home—at 18 feet above sea level, my home is the highest ground I can hope for. For the entire twenty hours I spent waiting out Irma in 2017, I was sure that any minute we would all be dead. I thought the hurricane was going to hit TPGS straight on and would cause an accident like Fukushima. Up until that point, during hurricanes I mostly worried about wind damage. Not anymore. Now there's something else to worry about—whether the next hurricane won't miss TPGS like Irma did.

6. I'm also concerned about releases from the TPGS's cooling canal system. We live on limestone here, which means there is only a small distance between fresh and saltwater underground. It is a very fragile system. Once it is destroyed, there is no undoing it. I fear that if TPGS remains open, our groundwater will be irreparably impacted.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge, information and belief and that this declaration was executed on March 4, 2020 in Miami, Florida.

Alan Thomas

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UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT

FRIENDS OF THE EARTH, NATURAL RESOURCES DEFENSE COUNCIL, INC., and MIAMI WATERKEEPER Petitioners, v. UNITED STATES NUCLEAR REGULATORY COMMISSION and UNITED STATES OF AMERICA, Respondents.	No. 20-1026

<u>DECLARATION OF DANIEL PAROBOK</u>

I, Daniel Parobok, declare as follows:

1. I am a member of Miami Waterkeeper and I make this declaration in support of petitioner's request for a hearing and leave to intervene in Florida Power & Light Co.'s application for a second license renewal of its operating licenses for Turkey Point Nuclear Generating Units 3 and 4.

2. Miami Waterkeeper, Inc. ("Waterkeeper," also known as Biscayne Bay Waterkeeper, Inc.) is a Florida non-profit organization with a mission to defend, protect, and preserve the aquatic integrity of South Florida's watershed and wildlife through citizen involvement and community action. As its advocate,

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Waterkeeper seeks to eliminate or mitigate threats to South Florida's coastal waters. Through its work, Waterkeeper hopes to ensure a clean and vibrant South Florida watershed and coastal culture for generations to come. Waterkeeper uses education, community outreach, and legal advocacy to protect South Florida's marine ecosystems, marine life, and coral reefs. Waterkeeper is a member of the Waterkeeper Alliance, an international organization uniting more than 190 Waterkeeper affiliates across the globe. Waterkeeper has approximately 76 members.

3. For four years, I lived and worked in Miami-Dade County as an Environmental Scientist. I have recently moved to Monroe County where I work as a biologist.

4. As a member of Miami Waterkeeper, I use and enjoy the waters of South Florida, including those of Biscayne National Park and the area near Turkey Point for recreational purposes. I regularly launch my boat out of Black Point Marina or Homestead Bayfront Park to go fishing along the mangrove shoreline and in the seagrass flats of Biscayne Bay, targeting species such as bonefish, permit, snapper, tarpon, sheepshead, snook, and redfish. I spend a significant amount of time boating and fishing in Biscayne Bay, Card Sound, Barnes Sound, and Florida Bay.

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5. I also enjoy viewing wildlife such as manatees, turtles, birds, dolphins, and crocodiles when I recreate in these areas. In a professional capacity, these species are significant to me as well. I am a biologist by trade and my job involves conducting benthic and land-based field surveys, evaluating environmental permit applications, conducting site inspections, and ensuring compliance with local, state, and federal laws. In my professional work, I regularly conduct listed species surveys for wildlife including turtles, cara caras, queen conch, woodstorks, scrub jays, red cockaded woodpeckers, everglades snail kites, sand skinks, and gopher tortoises. Many of these species rely on a healthy interaction between terrestrial and marine environments, with a particular emphasis on wetland habitats. Without healthy wetlands, many listed species and other flora and fauna will suffer.

6. As a resident of the Florida Keys, I rely on the Biscayne Aquifer as a primary source of drinking water. I am concerned that the hypersaline plume from Turkey Point's Cooling Canal System is approaching the drinking water wellheads for the Florida Keys at more than a foot per day.

7. My personal and professional interests will be directly affected by the continued operation of Turkey Point's Cooling Canal System. Specifically, I am concerned that the hypersaline plume from the canals will contaminate my primary source of drinking water. I am also concerned that the canals are degrading natural

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habitat that I rely on for both recreational and professional purposes. Lastly, I live 28 miles from Turkey Point, and if an accident happened and a radiation release occurred, my personal safety may be at risk. I endorse Miami Waterkeeper seeking to intervene on my behalf in the Turkey Point relicensing proceeding.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge, information, and belief.

Executed on this 5 day, March 2020.

Daniel Parobok

UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT

FRIENDS OF THE EARTH, NATURAL RESOURCES DEFENSE COUNCIL, INC., and MIAMI WATERKEEPER	)	
Petitioners,	)	No. 20-1026
v.	)	
UNITED STATES NUCLEAR REGULATORY COMMISSION and UNITED STATES OF AMERICA,	)	
Respondents.	)	

DECLARATION OF RACHEL SILVERSTEIN, PH.D

I, Rachel Silverstein, declare as follows:

1. I am the Executive Director of Miami Waterkeeper, and I make this declaration in support of Petitioners' Petition for Review.

2. Miami Waterkeeper (also known as Biscayne Bay Waterkeeper, Inc.) ("Waterkeeper") is a Florida non-profit organization with a mission to defend, protect, and preserve the waters of South Florida from the Everglades to the aquifers to the reefs through citizen involvement and community action. As its advocate, Waterkeeper seeks to eliminate or mitigate threats to South Florida's coastal waters. Through its work, Waterkeeper hopes to ensure a clean and vibrant

South Florida watershed and coastal culture for generations to come. Waterkeeper uses community outreach, scientific research, and legal advocacy to protect South Florida's marine ecosystems, marine life, and coral reefs. Waterkeeper is a member of the Waterkeeper Alliance, an international organization uniting more than 300 Waterkeeper organizations and affiliates across the globe. Miami Waterkeeper has approximately 75 members.

3. In addition to serving as Executive Director of Miami Waterkeeper, I am a member of the organization and I also serve as the "Miami Waterkeeper." A Waterkeeper is a full-time, paid employee of an organizational member of the Waterkeeper Alliance who serves as a non-governmental public advocate for an identified watershed. I hold a B.A. in Evolution, Ecology and Environmental Biology from Columbia University, and I received a Ph.D. in the Department of Marine Biology and Fisheries from the University of Miami's Rosenstiel School for Marine and Atmospheric Science. My job as Miami Waterkeeper involves patrolling the bays, monitoring and testing water quality, investigating pollution problems, educating the public, enforcing state and federal environmental laws, and working with civic leaders to support our mission.

4. Many members of Miami Waterkeeper recreate, study, enjoy, and work in the waters in South Florida, including those of the Florida Keys National Marine Sanctuary, Biscayne National Park, and Everglades National Park near

Turkey Point. Waterkeeper's members observe and interact with marine organisms such as fish, lobsters and other invertebrates (such as corals), sea turtles, and marine mammals through wildlife observation, research, photography, scuba diving, and recreational fishing. Our members also visit the terrestrial portions of the two national parks and other freshwater wetlands areas near Turkey Point and observe, interact with and value terrestrial organisms that depend on freshwater wetlands such as crocodiles, panthers, snakes, turtles, and a wide variety of birds. These activities require healthy freshwater wetlands, which in turn requires continued protection of the groundwater underneath those wetlands.

5. Members of Miami Waterkeeper also rely on the Biscayne Aquifer as a source of potable water. Consequently, Plaintiffs' members are concerned and directly affected by the consequences of Turkey Point's use of a cooling canal system to dispose of waste heat, including salinization of the Biscayne Aquifer, degradation of freshwater wetlands, discharges of pollution into Biscayne Bay, and the taking of American Crocodiles and harm to their Designated Critical Habitat.

6. I am a resident of South Florida, and I also personally share these concerns. I enjoy boating in southern Biscayne Bay, as well as scuba diving, snorkeling, and camping in the area. My family and I frequently visit Everglades National Park as well. I plan to continue visiting our spectacular national parks and

marine sanctuaries, and enjoying viewing the unique wildlife that depend on clean water and sustained freshwater flow for their habitats and lifecycles.

7. As a resident of Miami-Dade County, I also rely on the Biscayne Aquifer as a primary source of drinking water. I am concerned that the hypersaline plume emanating from Turkey Point's Cooling Canal System is contaminating the Biscayne Aquifer.

8. Lastly, I live approximately 30 miles from Turkey Point, and if an accident happened and a radiation release occurred, my personal safety may be at risk.

9. For these reasons, the relicensing of Turkey Point Units 3 and 4 is of great interest to me, to Miami Waterkeeper and to our membership. We have thus sought to appeal the Nuclear Regulatory Commission's decision to renew Turkey Point's operating licenses until 2052 and 2053 in order to ensure that the most important environmental impacts, and any mitigation alternatives, are fully and adequately considered so that a responsible and informed decision can be reached before making a final decision on whether to relicense Turkey Point Units 3 & 4. I endorse Miami Waterkeeper's effort to appeal the Nuclear Regulatory Commission's license renewal decision on my behalf. I am also a member of petitioner Natural Resources Defense Council.

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I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge, information, and belief.

Executed on March 5, 2020.

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Rachel Silverstein, Ph.D.

COMMISSIONERS:

Kristine L. Svinicki, Chairman
Jeff Baran
Annie Caputo
David A. Wright

In the Matter of FLORIDA POWER & LIGHT CO. (Turkey Point Nuclear Generating Units 3 and 4)	Docket Nos. 50-250-SLR 50-251-SLR

CLI-20-03

MEMORANDUM AND ORDER

Today we address the referred ruling that interpreted 10 C.F.R. § 51.53(c)(3) as applying to a subsequent license renewal applicant's preparation of an environmental report. We accept the referral from the Atomic Safety and Licensing Board, uphold the ruling, and hold that the NRC Staff may rely on the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS) and 10 C.F.R. Part 51, Subpart A, Appendix B, Table B-1 (Table B-1) to evaluate environmental impacts of Category 1 issues.

I. BACKGROUND

The Board ruled on multiple petitions to intervene and requests for hearing in LBP-19-3 related to the application from Florida Power & Light Company (FPL) to permit an additional twenty years of operation for two nuclear power reactors, Turkey Point Nuclear Generating Units 3 and 4.[1] The Board granted the petition to intervene of Natural Resources Defense

[1] LBP-19-3, 89 NRC 245 (2019); *see* Letter from William D. Maher, FPL, to NRC Document Control Desk (Apr. 10, 2018) (ADAMS accession no. ML18113A132 (package) and ML18102A521) (transmitting a revised subsequent license renewal application).

Council, Friends of the Earth, and Miami Waterkeeper (collectively, Petitioners), which challenged the environmental report that FPL submitted as part of its subsequent license renewal application. Petitioners submitted five contentions challenging the environmental report, and the Board admitted two in part.[2] Contention 1-E, as admitted, claims that FPL should have considered mechanical draft cooling towers as a reasonable alternative to the cooling canal system in light of the adverse impact of the system on the threatened American crocodile and its critical seagrass habitat.[3] Contention 5-E, as admitted, relates to the impact of ammonia releases on endangered and threatened species and their critical habitat during the renewal period.[4] As relevant here, the Board did not admit the other contentions, or any portions thereof, because of its interpretation that section 51.53(c)(3) applies to subsequent license renewal.[5] The Board also referred its ruling on the scope of 10 C.F.R. § 51.53(c)(3) pursuant to 10 C.F.R. § 2.323(f)(1).[6]

The Board found that Contentions 1-E and 5-E migrated to become challenges to the Draft Supplemental Environmental Impact Statement (Draft SEIS) after its publication.[7] But it also dismissed these contentions because they were admitted as contentions of omission, and

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[2] LBP-19-3, 89 NRC at 285-95. The Board also admitted similar contentions filed by Southern Alliance for Clean Energy (SACE), but SACE withdrew from the proceeding. *Id.* at 301; *Southern Alliance for Clean Energy's Notice of Withdrawal* (Apr. 9, 2019). We therefore only address the contentions submitted by the Petitioners in this decision.

[3] LBP-19-3, 89 NRC at 287.

[4] *Id.* at 293-94.

[5] The Board based its determination on the admissibility of the contentions proffered on our contention admissibility standards set forth in 10 C.F.R. § 2.309(f)(i)-(vi). LBP-19-3, 89 NRC at 286-95.

[6] *Id.* at 273 n.46. Judge Abreu filed a separate opinion, in which she outlined her bases for disagreeing with the majority's conclusion that section 51.53(c)(3) applies to subsequent license renewal.

[7] LBP-19-6, 90 NRC 17, 20 (2019).

the Draft SEIS addressed the omissions.[8] Petitioners moved to submit amended and new contentions based on the Draft SEIS, in which they sought to either migrate or amend Contentions 1-E and 5-E and admit four new contentions challenging the adequacy of the Draft SEIS.[9] The Board found these contentions inadmissible and terminated the proceeding.[10]

FPL appealed the decision[11] and later notified us that its appeal was moot.[12] As discussed below, we dismiss the appeal as moot, and we accept the Board's referral and uphold the Board's ruling on the interpretation of 10 C.F.R. § 51.53.

II. DISCUSSION

A. FPL's Appeal

In its appeal, FPL argued that the Board should not have admitted Contention 1-E and Contention 5-E.[13] Following the Staff's issuance of the Draft SEIS, FPL asked the Board to dismiss those contentions as moot based on new information in the Draft SEIS.[14] The Board concluded that the new information in the Draft SEIS cured the omissions identified in the

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[8] *Id.* at 21, 23-24.

[9] *Natural Resources Defense Council's, Friends of the Earth's, and Miami Waterkeeper's Amended Motion to Migrate Contentions & Admit New Contentions in Response to NRC Staff's Supplemental Draft Environmental Impact Statement* (revised June 28, 2019), at 1-2 (Motion to Migrate and Admit Amended and New Contentions).

[10] LBP-19-8, 90 NRC 139 (2019).

[11] *Florida Power & Light Company's Notice of Appeal of LBP-19-3* (Apr. 1, 2019). Petitioners and the Staff opposed the appeal. *Opposition of Natural Resources Defense Council, Friends of the Earth, and Miami Waterkeeper to Florida Power & Light Company's Appeal of the Atomic Safety and Licensing Board's Ruling in LBP-19-3* (Apr. 26, 2019); *NRC Staff's Brief in Response to Florida Power & Light Company's Appeal of LBP-19-3* (Apr. 26, 2019).

[12] *Notice Regarding Dismissal of Contentions* (July 15, 2019) (FPL Notice).

[13] *Brief in Support of Florida Power & Light Company's Appeal of LBP-19-3* (Apr. 1, 2019), at 3.

[14] *FPL's Motion to Dismiss Joint Petitioners' Contention 1-E As Moot* (May 20, 2019); *FPL's Motion to Dismiss Joint Petitioners' Contention 5-E As Moot* (May 20, 2019).

contentions and granted FPL's motion to dismiss.[15] FPL then notified us that its appeal of LBP-19-3 was moot.[16] We agree and therefore dismiss FPL's appeal.

B. Interpretation of Section 51.53

1. *Background*

This proceeding presents our first review of a subsequent license renewal application, but our safety regulations in Part 54 have long contemplated the possibility.[17] Our license renewal regulations recognize that after accounting for the effects of aging, our existing "regulatory process [in Part 50] is adequate to ensure that the licensing bases of all currently operating plants provides and maintains an acceptable level of safety so that operation will not be inimical to [the] public health and safety or [the] common defense and security."[18] Apart from aging management issues, plant operation under a renewed license is sufficiently similar to operation during the previous term such that our existing oversight processes are adequate to ensure safety.[19]

In addition to a safety review, the renewal of a nuclear power plant operating license requires the preparation of an environmental impact statement (EIS) to comply with the National Environmental Policy Act (NEPA).[20] The EIS includes the Staff's analysis that considers and weighs the environmental effects of the proposed action. To support the preparation of EISs for

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[15] LBP-19-6, 90 NRC at 19.

[16] FPL Notice at 1-2.

[17] Nuclear Power Plant License Renewal, Revisions, 60 Fed. Reg. 22,461, 22,494 (May 8, 1995) (License Renewal Revisions); 10 C.F.R. § 54.31(d).

[18] License Renewal Revisions, 60 Fed. Reg. at 22,464.

[19] *See, e.g.*, *Northern States Power Co.* (Prairie Island Nuclear Generating Plant, Units 1 and 2), CLI-10-27, 72 NRC 481, 491 (2010).

[20] *See, e.g.*, 10 C.F.R. § 51.20(b)(2).

license renewal, the NRC Staff issued the GEIS in 1996.[21] The 1996 GEIS for license renewal assessed the environmental impacts associated with the continued operation of nuclear power plants during the license renewal term. The NRC also promulgated a rule that codified the findings of the 1996 GEIS into its regulations in Table B-1.[22] The intent of the GEIS was to improve the efficiency of license renewal by determining which environmental impacts would result in essentially the same impact at all nuclear power plants (i.e., generic or Category 1 issues) and which ones could result in different levels of impacts at different plants and would require a plant-specific analysis to determine the impacts.[23] In developing the GEIS, we relied on the following factors:

> (1) License renewal will involve nuclear power plants for which the environmental impacts of operation are well understood as a result of lessons learned and knowledge gained from operating experience and completed license renewals.
>
> (2) Activities associated with license renewal are expected to be within this range of operating experience; thus, environmental impacts can be reasonably predicted.
>
> (3) Changes in the environment around nuclear power plants are gradual and predictable.[24]

For the issues that could not be generically addressed, also known as Category 2 issues, the Staff prepares plant-specific supplements to the GEIS (i.e., a plant-specific supplemental EIS (SEIS)).[25]

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[21] "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (Final Report), NUREG-1437, vols. 1-2 (May 1996) (ML040690705, ML040690738) (1996 GEIS).

[22] *See* Environmental Review for Renewal of Nuclear Power Plant Operating Licenses; Final Rule, 61 Fed. Reg. 28,467 (June 5, 1996) (1996 Final Rule).

[23] *See* "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (Final Report), NUREG-1437, rev. 1, vols. 1-3 (June 2013), at S-1 (ML13106A241, ML13106A242, ML13106A244) (2013 GEIS).

[24] *Id*. at 1-2.

[25] *Id.*

While the agency is responsible for complying with NEPA, the process of creating an EIS begins with the license renewal applicant. Pursuant to sections 51.45(a) and 51.53(c)(1), license renewal applicants must submit an environmental report to the NRC "to aid the Commission in complying with section 102(2) of NEPA."[26] The Staff reviews the environmental report submitted by the applicant and uses it to draft the plant-specific SEIS.

As stated in the 1996 final rule that incorporated the findings of the GEIS into Table B-1, the NRC recognized that environmental impact issues may change over time and that additional issues may require consideration.[27] The NRC indicated that it intended to review the material in Table B-1 on a ten-year cycle.[28] In 2013, the NRC issued a revision to the GEIS and updated the corresponding regulations.[29] The 2013 GEIS noted that plant-specific environmental reviews had been completed for approximately forty nuclear plant sites (seventy reactor units) since the publication of the original GEIS in 1996.[30] The 2013 GEIS revision "intended to incorporate lessons learned and knowledge gained from these plant-specific environmental reviews, as well as changes to Federal laws and new information and research published since the 1996 GEIS."[31] The Staff noted that the purpose of the review for the 2013 GEIS was to determine if the findings presented in the 1996 GEIS remained valid.[32]

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[26] 10 C.F.R. § 51.14(a).

[27] *See* 2013 GEIS at S-2.

[28] *Id.*; 10 C.F.R. pt. 51, subpt. A, app. B.

[29] The NRC began its ten-year cycle review in 2003. The final rule and GEIS were published in 2013. Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses; Final Rule, 78 Fed. Reg. 37,282, 37,284 (June 20, 2013) (2013 Final Rule).

[30] 2013 GEIS at S-2.

[31] *Id.*

[32] *Id.* at 1-7.

In the 1996 GEIS, the Staff analyzed the impact of license renewal on ninety-two environmental issues organized by power plant systems and activities, of which sixty-eight were determined to be generic, or Category 1 issues.[33] The 1996 GEIS discussed these Category 1 issues, and therefore, these issues did not require a plant-specific assessment unless there was new and significant information that would change the conclusions in the GEIS.[34] The 2013 GEIS carried forward seventy-eight environmental impact issues for consideration and arranged them by resource area.[35]

2. *Referred Ruling*

In determining the admissibility of the Petitioners' contentions, the Board found it necessary to determine the scope of section 51.53(c)(3), and, specifically, whether it may be applied to a subsequent license renewal applicant.[36] If so, the Board reasoned, then FPL and other subsequent license renewal applicants may rely on the GEIS and Appendix B and thereby exclude consideration of Category 1 issues from their environmental reports unless there is new and significant information that would change the conclusions in the GEIS.[37] Further, if section 51.53(c)(3) applies here, Petitioners would have been obligated to submit a rule waiver petition pursuant to section 2.335 to raise contentions challenging Category 1 issues.[38]

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[33] 1996 GEIS at xxxv; 2013 GEIS at 1-5.

[34] 1996 GEIS at xxxv; 2013 GEIS at 1-7; *see Marsh v. Oregon Natural Res. Council*, 490 U.S. 360, 374 (1989).

[35] 2013 GEIS at 1-5, 1-7.

[36] LBP-19-3, 89 NRC at 263.

[37] *See* 2013 GEIS at 1-4.

[38] *See Exelon Generation Co., LLC* (Limerick Generating Station, Units 1 and 2), CLI-12-19, 76 NRC 377, 387 (2012).

Section 51.53(c), "Operating license renewal stage," requires an "applicant for renewal of a license to operate a nuclear power plant" to submit an environmental report with its application.[39] Section 51.53(c)(3) states:

> For those applicants seeking an initial renewed license and holding an operating license, construction permit, or combined license as of June 30, 1995, the environmental report shall include the information required in paragraph (c)(2) of this section subject to the following conditions and considerations:
>
> (i) The environmental report for the operating license renewal stage is not required to contain analyses of the environmental impacts of the license renewal issues identified as Category 1 issues in appendix B to subpart A of this part.
>
> (ii) The environmental report must contain analyses of the environmental impacts of the proposed action, including the impacts of refurbishment activities, if any, associated with license renewal and the impacts of operation during the renewal term, for those issues identified as Category 2 issues in appendix B to subpart A of this part . . . .
>
> (iii) The report must contain a consideration of alternatives for reducing adverse impacts, as required by § 51.45(c), for all Category 2 license renewal issues in appendix B to subpart A of this part. No such consideration is required for Category 1 issues in appendix B to subpart A of this part.
>
> (iv) The environmental report must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.[40]

The Board found that the plain regulatory language does not resolve whether section 51.53(c)(3) can be applied to subsequent license renewal applicants; "it neither directs the Commission to apply section 51.53(c)(3) to [subsequent license renewal] applicants, nor does it forbid the Commission from doing so."[41] Because the Board found the regulations silent as to subsequent license renewal applicants, the Board looked to regulatory language and structure;

[39] 10 C.F.R. § 51.53(c)(1).

[40] *Id.* § 51.53(c)(3).

[41] LBP-19-3, 89 NRC at 265.

regulatory purpose and history; the agency's interpretative rules; and administrative efficiency, logic, and practicality.[42] Based on its analysis, the Board concluded that the Commission intended section 51.53(c)(3) to apply to all license renewal applicants, including those for subsequent license renewal.[43] Therefore, the Board concluded that FPL's environmental report did not need to consider Category 1 issues on a site-specific basis but could rely on the Category 1 findings in the GEIS and Table B-1.[44] The Board assessed Petitioners' contentions under this interpretation of the regulation.[45]

The Board noted that the referred ruling is a significant legal issue of first impression, and it is likely to recur in other proceedings until resolved by the Commission.[46] We agree and address it now.

As noted above, the Board found that the plain regulatory language does not provide clear direction for subsequent license renewal applicants.[47] Therefore, the Board was "guided by the Supreme Court's approach in *Fed. Express Corp. v. Holowecki*, 552 U.S. 389 (2008), where in [determining] the scope of a regulatory provision in the face of regulatory silence, the Court conducted a holistic analysis."[48] The Board likewise conducted a holistic analysis of

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[42] *Id.* at 265, 272.

[43] *Id.*

[44] *Id.* at 272-73.

[45] *Id.* at 273.

[46] *Id.* at 273 n.46; *see also* 10 C.F.R. § 2.323(f)(1). The Board noted that the issue was pending before a licensing board in another subsequent license renewal proceeding, *Peach Bottom*. LBP-19-3, 89 NRC at 273 n.46. In light of the impact of our decision on this referred ruling to the *Peach Bottom* parties, we reviewed and considered the pleadings and arguments related to section 51.53(c)(3) in that case before reaching our decision here.

[47] LBP-19-3, 89 NRC at 265.

[48] *Id.*

section 51.53(c)(3) to determine the Commission's intent.[49] This holistic approach is consistent with our observation that "[i]n construing a regulation's meaning, it is necessary to examine the agency's entire regulatory scheme."[50] In the similar context of statutory interpretation, the Supreme Court has explained that

> [s]tatutory construction . . . is a holistic endeavor. A provision that may seem ambiguous in isolation is often clarified by the remainder of the statutory scheme—because the same terminology is used elsewhere in a context that makes its meaning clear, or because only one of the permissible meanings produces a substantive effect that is compatible with the rest of the law.[51]

We agree with the Board that the regulatory language is ambiguous because it "neither directs the Commission to apply section 51.53(c)(3) to [subsequent license renewal] applicants, nor does it forbid the Commission from doing so."[52] We concur that a holistic reading of Part 51 supports the conclusion that section 51.53(c)(3) covers all applicants for license renewal, including subsequent license renewal applicants.

The Board examined Petitioners' proposed reading of section 51.53(c)(3) in the broader context of Part 51. We agree with the Board's well-reasoned determination that application of section 51.53(c)(3) to only initial license renewal applicants would render that provision incompatible with the other license renewal provisions in Part 51.[53] The Board noted that while the environmental report assists the agency, the NRC has the ultimate responsibility to comply

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[49] *Id.*

[50] *Northeast Nuclear Energy Co.* (Millstone Nuclear Power Station, Unit 3), CLI-01-10, 53 NRC 353, 366 (2001).

[51] *United Sav. Ass'n of Tex. v. Timbers of Inwood Forest Assocs.*, 484 U.S. 365, 371 (1988) (citations omitted).

[52] LBP-19-3, 89 NRC at 265.

[53] *Id.* at 274 (noting that "the dissent does not dispute that its restrictive reading of section 51.53(c) places that regulation in irreconcilable tension with 'sections 51.71(d), 51.95(c), and 10 C.F.R. Part 51, Subpart A, Appendix B'").

with NEPA by preparing a SEIS in license renewal proceedings.[54] In preparing a SEIS for a license renewal, the Staff must follow the provisions of sections 51.71(d) and 51.95(c), which in turn refer to Table B-1. As explained below, the plain text of those regulations cannot be reconciled with Petitioners' reading of section 51.53(c).

a. Context and Structure of Part 51

(1) SECTION 51.95

Section 51.95, "Postconstruction Environmental Impact Statements," provides the requirement for the NRC to prepare an EIS at the initial operating license stage, license renewal stage, and the post-operating license stage. Section 51.95(c) provides, "[i]n connection with the renewal of an operating license or combined license for a nuclear power plant under 10 [C.F.R.] parts 52 or 54 of this chapter, the Commission shall prepare an environmental impact statement, which is a supplement to" the 2013 GEIS. With regard to Category 1 issues, the regulation sets forth the following requirement:

> [i]n order to make recommendations and reach a final decision on the proposed action, the NRC [S]taff, adjudicatory officers, and Commission shall integrate the conclusions in the generic environmental impact statement for issues designated as Category 1 with information developed for those Category 2 issues applicable to the plant under § 51.53(c)(3)(ii) and any new and significant information.[55]

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[54] *Id.* at 263.

[55] 10 C.F.R. § 51.95(c)(4). The reference to "new and significant information" reflects our ongoing obligation to supplement any final EIS prior to undertaking an agency action upon discovering information that provides a seriously different picture of the environmental consequences. *See Marsh*, 490 U.S. at 374; 10 C.F.R. § 51.92. Because the 2013 GEIS already resolves the Category 1 issues and the GEIS for Continued Storage of Spent Nuclear Fuel already evaluates storage of nuclear waste after the licensing term, this language reflects the agency's obligation to consider whether there is any new information with respect to those issues before taking final action. *See* "Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel" (Final Report), NUREG-2157, vols. 1-2 (Sep. 2014) (ML14196A105, ML14196A107). Section 51.53(c)(3)(iv) is our only regulatory provision that implements the requirements for license renewal applicants to provide new and significant information in the environmental report, which further supports our reading that all license renewal applicants should reference section 51.53(c)(3).

Unlike section 51.53(c), section 51.95 does not refer to initial license renewals. Rather, by its terms it does not differentiate between initial and subsequent license renewals. And by its terms, the NRC must "integrate the conclusions in the generic environmental impact statement for issues designated as Category 1" into the agency's final SEIS.[56] This requirement is inconsistent with interpreting section 51.53(c)(3) to prohibit subsequent license renewal applicants from relying on the findings in the 2013 GEIS for Category 1 issues.

Like the Board, we find section 51.95(c)(4)'s reference to section 51.53(c)(3)(ii) particularly instructive.[57] For all license renewal proceedings, including subsequent license renewals, section 51.95(c)(4) requires the NRC to rely on the information developed for Category 2 issues "applicable to the plant under § 51.53(c)(3)(ii)." As the Board observed, this language strongly suggests that the Commission did not intend to restrict section 51.53(c)(3) to initial license renewal applicants.[58] We agree with the Board that Petitioners' interpretation, read in the broader context of Part 51, would not further the regulatory purpose of Part 51.

(2) SECTION 51.71

Similarly, Petitioners' interpretation of section 51.53(c)(3) is inconsistent with section 51.71, "Draft Environmental Impact Statement – Contents." Specifically, section 51.71(d) states that

> [t]he draft supplemental environmental impact statement for license renewal prepared under § 51.95(c) will rely on conclusions as amplified by the supporting information in the GEIS for issues designated as Category 1 in [Table B-1 and] must contain an analysis of those issues identified as Category 2 in [Table B-1].

Again, section 51.71(d) on its face does not differentiate between initial and subsequent license renewals. And like section 51.95(c), section 51.71(d) directs the agency to analyze Category 2

[56] 10 C.F.R. § 51.95(c)(4).

[57] *See* LBP-19-3, 89 NRC at 267.

[58] *Id.*

issues in the Draft SEIS, but to rely on the 2013 GEIS for Category 1 issues. Here too, Petitioners' reading of section 51.53(c)(3) is inconsistent with other provisions in our regulations as it would require an applicant to provide analyses of Category 1 issues that the agency may not use in preparing the Draft SEIS because section 51.71(d) already requires the agency to consider the codified conclusions in Table B-1 for Category 1 issues.[59]

Further, those codified conclusions, located in Table B-1, apply to all license renewals. Appendix B to Part 51 states that "[t]he Commission has assessed the environmental impacts associated with granting a renewed operating license for a nuclear power plant to a licensee who holds either an operating license or construction permit as of June 30, 1995." The appendix further specifies that "Table B-1 summarizes the Commission's findings on the scope and magnitude of environmental impacts of renewing the operating license for a nuclear power plant." Table B-1 "represents the analysis of the environmental impacts associated with the renewal of *any* operating license and is to be used in accordance with § 51.95(c)."[60] Once more, a plain reading of Appendix B demonstrates that Petitioners' interpretation of section 51.53(c)(3) is not compatible with other Part 51 provisions on license renewal. Those provisions require the NRC to rely on the Category 1 findings in the 2013 GEIS when preparing the Draft and Final SEIS for any license renewal. Petitioners' interpretation would require subsequent license renewal applicants to prepare additional analysis of these same issues that the agency could not consider when preparing its own environmental analysis.

The dissenting Board opinion suggests that one way to address this infirmity in Petitioners' interpretation could be to read the word "initial" into sections 51.71(d) and 51.95(c)

[59] While some portion of this analysis would address whether new and significant information impacts any Category 1 issues, most of the analysis would simply reconsider information that the 2013 GEIS already thoroughly addressed.

[60] 10 C.F.R. pt. 51, subpt. A, app. B (emphasis added).

as well as Appendix B.[61] But this solution would have us read more into other regulations than the Petitioners' assert the Staff's and Applicant's interpretations read out of section 51.53(c)(3). Moreover, this solution limits the applicability of these provisions to initial license renewal, contrary to the intent and context of Part 51 discussed below.

(3) SECTION 51.53

Additionally, we have previously stated that regulatory interpretation should be informed by "the language and structure of the provision itself."[62] The language and structure of section 51.53(c)(3) further supports the Board's nonrestrictive reading. As noted above, the body of section 51.53(c)(3) states that applicants for initial license renewals must address its four subsections. Subsection (c)(3)(i) excuses applicants from analyzing Category 1 issues, subsection (c)(3)(ii) identifies Category 2 issues that applicants must analyze for specific plant designs, subsection (c)(3)(iii) directs applicants to evaluate mitigation for Category 2 issues, and subsection (c)(3)(iv) requires the applicants to consider new and significant information related to license renewal.

While the parties strongly disagree over whether subsequent license renewal applications generally should address Category 1 issues, the parties agree that all license renewal applicants, subsequent and initial, must address Category 2 issues.[63] But, the discussion on Category 2 issues in subsection (c)(3)(ii) notes that applicants for certain plants

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[61] LBP-19-3, 89 NRC at 308-09 (Abreu, J., concurring in part and dissenting in part).

[62] *Millstone*, CLI-01-10, 53 NRC at 361.

[63] *Compare Reply in Support of Request for Hearing and Petition to Intervene Submitted by Friends of the Earth, Natural Resources Defense Council, and Miami Waterkeeper* (Sept. 10, 2018), at 4-5 (Reply), *with Applicant's Surreply to New Arguments Raised in Reply Pleadings* (Sept. 20, 2018), at 4 (FPL Surreply), and *NRC Staff's Response to the Applicant's Surreply and the Petitioners' Response, Regarding the Applicability of 10 C.F.R. § 51.53(c)(3) to Subsequent License Renewal Applications* (Nov. 2, 2018) at 5-6 (Staff Response).

need only analyze certain issues based on plant design. For example, subsection (c)(3)(ii)(A) reads,

> If the applicant's plant utilizes cooling towers or cooling ponds and withdraws makeup water from a river, an assessment of the impact of the proposed action on water availability and competing water demands, the flow of the river, and related impacts on stream (aquatic) and riparian (terrestrial) ecological communities must be provided. The applicant shall also provide an assessment of the impacts of the withdrawal of water from the river on alluvial aquifers during low flow.

Thus, this subsection reflects the sensible observation that plants that have a design that will have certain impacts on water resources should analyze those impacts while other plant designs that do not have such impacts need not analyze them. In contrast, other subsections in (c)(3)(ii) indicate that all applicants should analyze impacts that will occur during the renewal period regardless of design, such as potential impacts to historic and cultural resources.[64] In this manner, subsection (c)(3)(ii) provides an essential roadmap for both initial and subsequent license renewal applicants with respect to which Category 2 issues should be analyzed based on the design of the plant. Indeed, before the Board, Petitioners argued that the applicant was required to meet the terms of section 51.53(c)(3)(ii) and (iii).[65] But, Petitioners have not explained how the word "initial" in section 51.53(c)(3) would restrict the applicability of subsection (i) to subsequent license renewals but not subsections (ii) and (iii), and we are unable to do so. As a result, the regulatory language and structure of section 51.53(c)(3) itself further supports the Board's holistic reading.[66]

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[64] *E.g.* 10 C.F.R. § 51.53(c)(3)(ii)(K).

[65] Reply at 14, 17, 19, 21, 40-41 n.148, 41 n.152, 52 n.194.

[66] *See Millstone*, CLI-01-10, 53 NRC at 361.

b. Regulatory History

(1) REGULATORY UPDATE FROM 2013

On balance, the regulatory history of Part 51 also supports our conclusion that applicants for a subsequent license renewal may utilize section 51.53(c)(3) and the GEIS. The regulatory history also confirms that the NRC considered subsequent license renewal in its analysis of Category 1 issues in the 2013 updates to the GEIS and provided the public with notice and an opportunity to comment.

Section 51.53(c)(3) directs license renewal applicants to analyze Category 2 issues, and it states that applicants are not required to analyze Category 1 issues, which are analyzed in the GEIS. As noted above, the agency most recently updated the GEIS and correspondingly amended its regulations in 2013.[67] Consequently, the 2013 GEIS and its accompanying rulemaking documents are the most current and reliable sources for interpreting the meaning of the regulations.

Among other things, the 2013 rulemaking reorganized, consolidated, and reclassified certain Category 1 and 2 issues.[68] There, the agency set forth the requirement for an applicant and the Staff to perform site-specific environmental analyses of Category 2 issues "[f]or *each* license renewal application."[69] This statement does not differentiate between initial and subsequent license renewals; instead, it directs such analysis for every license renewal.

Additionally, the text of the 2013 GEIS update also supports our determination that the GEIS covers the generic environmental impacts of all license renewals. Section 7 of the 2013 GEIS provides a glossary, which defines key words and phrases used in the document. The

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[67] *See generally* 2013 Final Rule.

[68] *See id.* at 37,282-83.

[69] *Id.* at 37,282 (emphasis added).

GEIS defines "License renewal term" as "[t]hat period of time past *the original or current license term* for which the renewed license is in force."[70] We agree with the Board that in light of this statement, the 2013 GEIS "explicitly purports to assess the environmental impacts associated with a [twenty-year] renewal period, regardless of whether this period follows the original license or a current renewed license."[71] A plain reading of the 2013 GEIS shows that the agency understood the subject of the GEIS—environmental impacts during a license renewal term—to include both impacts from an initial license renewal or a subsequent license renewal.[72] The Staff solicited extensive public comments on the 2013 GEIS by, among other methods, issuing notice in the *Federal Register*; holding public meetings; extending the comment period; and distributing the draft revised GEIS to stakeholders including environmental groups, representatives of American Indian Tribes, and various government agencies.[73]

Moreover, the documentation supporting the 2013 GEIS also supports a conclusion that the NRC intended to consider the impacts of subsequent license renewal in that document. Consistent with Executive Order 12,866, "Regulatory Planning and Review," the Staff prepared a Regulatory Analysis and provided it for Commission approval for the GEIS update and associated revision to Part 51 to reflect the revised GEIS.[74] That Regulatory Analysis compared the costs of the rulemaking with the expected benefits and concluded that the action was cost-

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[70] 2013 GEIS at 7-27 (emphasis added).

[71] LBP-19-3, 89 NRC at 270.

[72] *E.g.*, 2013 GEIS at 7-27, 1-2 ("The GEIS for license renewal of nuclear power plants assesses the environmental impacts that could be associated with license renewal and an additional [twenty] years of power plant operation.").

[73] 2013 GEIS, app. A § A.2.

[74] *See* "Final Rule: Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses," Commission Paper SECY-12-0063 (Apr. 20, 2012) (ML110760045 (package)), Encl. 2 (ML110760321) (Regulatory Analysis); *see also* Exec. Order No. 12,866, 3 C.F.R. 1993 Comp. at 638-49 (1994).

justified.[75] The 2009 Federal Register notice providing the draft GEIS for public comment contained a specific request for public comment on the draft Regulatory Analysis.[76] The draft Regulatory Analysis evaluated the costs of both initial and subsequent license renewal.[77] That evaluation carried forward to the Regulatory Analysis of the final GEIS, in which the Staff estimated "that a total of [thirty] license renewal applications (including applications for a second license renewal) will be received in the [ten-year] cycle following the effective date of the rule."[78] Therefore, the Staff's cost-justification recommendation—and the Commission's approval of that recommendation—was based on an understanding that the 2013 GEIS would cover all license renewal applications, both initial and subsequent.

Petitioners have identified select portions of the 2013 GEIS that appear to consider only one license renewal term in the "discussion of specific types of environmental impacts."[79] But

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[75] Regulatory Analysis at 68.

[76] Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, 74 Fed. Reg. 38,117, 38,132 (July 31, 2009).

[77] "Proposed Rulemaking – Environmental Protection Regarding the Update of the 1996 Generic Environmental Impact Statement for Nuclear Power Plant License Renewal," Commissioner Paper SECY-09-0034 (Mar. 3, 2009) (ML091050197 (package)), Encl. 2, at 15 (ML083460087) ("Some plants will become eligible for a second 20-year license extension after FY 2013. While the NRC understands that the possibility exists for license holders to submit a second 20-year license renewal application, no letters of intent have been received as of the issuance date of this document. The NRC conservatively estimates receiving 4 applications per year from FY 2014 through FY 2020.").

[78] *Id*. at 25.

[79] *Petitioners' Response to Applicant's Surreply* (Oct. 1, 2018), at 7-8. *See* 2013 GEIS at 4-138 to 4-139 ("If the reactor operates for [sixty] years, the cumulative increase in fatal cancer to an individual worker is estimated to be 3.6×10^{-3} (a [fifty] percent increase over the baseline of [forty] years of operations."); *id*. at 4-145 ("If the reactor operates for [sixty] years, it is estimated that the increase in fatal cancer risk to the [Maximumly Exposed Individual (MEI)] would range from 6×10^{-7} to 4.6×10^{-4} (a [fifty] percent increase over the baseline of [forty] years of operation); *id*. at 4-217 ("As discussed in the 1996 GEIS, the dose to the public from long-lived radionuclides after [forty] years of plant operation is expected to be negligible, and the increase in quantities of long-lived radionuclides after an additional [twenty] years would result in a negligible does (less than 0.1 person-rem."). Similarly, the dissenting opinion notes that the analysis of the impacts of severe accidents in the 2013 GEIS "expressly states that 'the revision

the 2013 GEIS is hundreds of pages long and analyzed seventy-eight issues; and as the Board noted, the 2013 GEIS generally used terminology that could apply to either an initial or subsequent license renewal.[80] Therefore, in determining the scope of the 2013 GEIS, the general definition of license renewal term (supported by the discussion in the Regulatory Analysis) provides the most accurate insight into the agency's understanding.

Additionally, we agree with the Staff that the Petitioners' arguments do not render the analysis in the GEIS inapplicable to subsequent license renewal. The Staff argues that instead, "the analyses in the GEIS concern the *incremental* effects of an additional [twenty] years of operation—regardless of whether the plant had operated for [forty] years or [sixty] years prior to the requested license renewal."[81] The Staff's insight is correct: the 2013 GEIS is not predicated on any particular feature of operation between years forty and sixty that would differ from years sixty to eighty. Moreover, in anticipation of the first subsequent license renewal applications, the Staff prepared an assessment of the agency's readiness to review the applications and provided a policy paper to the Commission.[82] That paper notes that the 2013 GEIS "is adequate for a future subsequent license renewal application."[83] Thus, the Staff, to whom we have delegated the responsibility to conduct environmental reviews for license renewal

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only covers one initial license renewal period for each plant (as did the 1996 GEIS).'" LBP-19-3, 89 NRC at 308 (Abreu, J., concurring in part and dissenting in part) (quoting 2013 GEIS, app. E, at E-2).

[80] LBP-19-3, 89 NRC at 265-66.

[81] Staff Response at 14-15.

[82] "Ongoing Staff Activities to Assess Regulatory Considerations for Power Reactor Subsequent License Renewal," Commission Paper SECY-14-0016 (Jan. 31, 2014), at 1 (ML14050A306).

[83] *Id*. at 3.

proceedings, has informed us on three separate occasions that the 2013 GEIS covers subsequent license renewals.[84]

(2) THE 1991 PROPOSED RULE AND THE 1996 FINAL RULE

The Board and the dissent disagreed over the meaning of the regulatory history supporting prior versions of the rule, given that some language in the regulatory history suggests that at one time the Commission may have intended to limit the applicability of the earlier version of the GEIS to initial license renewals.[85] We have previously observed that "[a]s the latest expression of the rulemakers' intent, the more recent regulation prevails if there is a perceived conflict with an earlier regulation."[86] Because the regulations at issue codify the 2013 GEIS, the prior regulatory history is a less reliable guide than that accompanying the 2013 rulemaking, which is the "latest expression of the rulemakers' intent."[87]

Nevertheless, some features of that rulemaking process provide additional insight into the agency's intent. The Board noted that while certain language *accompanying* the 1991 proposed rule purported to limit the application of the rule "to one renewal of the initial license

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[84] *Id.*; Staff Response at 14-15; Regulatory Analysis at 25. As noted previously, the Staff sought and received public comment on the rulemaking documents, including the 2013 GEIS. *See, e.g.*, 2013 GEIS, app. A § A.2.

[85] *Compare* LBP-19-3, 89 NRC at 265-66, *with id.* at 305-07 (Abreu, J., concurring in part and dissenting in part).

[86] *Millstone*, CLI-01-10, 53 NRC at 367 (*citing* 2B SUTHERLAND, STATUTORY CONSTRUCTION § 51.02 (1992)).

[87] *See id.* While the rulemaking accompanying the 2013 GEIS did not remove the word "initial" from section 51.53(c)(3), this does not necessarily contradict our determination to consider both subsequent and initial license renewals in the 2013 GEIS. Rather, the word "initial" reflects the possibility that while all initial license renewal applicants must address the conditions and considerations in section 51.53(c)(3), some subsequent license renewal applicants may take a different approach or use the same approach required for initial license renewal applicants. *See* 10 C.F.R. § 51.53(a). And ultimately the more significant determination, from a NEPA standpoint, is preparation of the Draft SEIS and Final SEIS pursuant to Table B-1, for which agency regulations do not distinguish between subsequent and initial renewals.

for up to [twenty] years beyond the expiration of the initial license," *the language in the proposed rule itself* did not include such a restriction to an initial license renewal.[88] The Board observed that neither the 1996 final rule nor any accompanying language included the restrictive phrase.[89] The Board determined that the omission of the limiting language supported a conclusion that the agency did not intend to limit the applicability of section 51.53(c)(3) to initial license renewal applications when it was promulgated.[90]

We note that certain aspects of the regulatory history support the Board's determination. For example, while the final rule was "consistent with the generic approach and scope" of the proposed rule, it also featured "several significant modifications."[91] Significantly, the proposed rule contained a generic "favorable cost-benefit balance for license renewal" found in proposed Appendix B.[92] In support of this finding, Appendix B in the proposed rule determined, "[l]icense renewal of an individual nuclear power plant is found to be preferable to replacement of the generating capacity with a new facility to the year 2020."[93] However, the final rule abandoned this approach. Instead, it introduced a "new standard that will require a determination of whether or not the adverse environmental impacts of license renewal are so great, compared with the set of alternatives, that preserving the option of license renewal for future decisionmakers would be unreasonable."[94] The final rule explained, "[c]onsideration of and

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[88] LBP-19-3, 89 NRC at 265 (citing Environmental Review for Renewal of Operating Licenses; Proposed Rule, 56 Fed. Reg. 47,016, 47,017 (Sept. 17, 1991) (1991 Proposed Rule)).

[89] *Id.* (citing 1996 Final Rule, 61 Fed. Reg. at 28,467).

[90] *Id.*

[91] 1996 Final Rule, 61 Fed. Reg. at 28,468.

[92] 1991 Proposed Rule, 56 Fed. Reg. at 47,018.

[93] *Id.* at 47,030.

[94] 1996 Final Rule, 61 Fed. Reg. at 28,468.

decisions regarding alternatives will occur at the site-specific stage."[95] Therefore, the proposed rule could only have applied to initial license renewals because it relied on a generic finding that no alternative to license renewal would be preferable through 2020 and most facilities would be unable to apply for subsequent license renewal until after that point in time.[96]

Further, the Board found that a regulatory purpose of Part 51 revisions was "to promote efficiency in the environmental review process for license renewal applications."[97] It noted that requiring subsequent license renewal applicants to analyze Category 1 issues (already covered by the GEIS and codified in Table B-1), on a site-specific basis would negate the regulatory purpose behind these Part 51 revisions.[98] We agree with the Board that Petitioners' interpretation of section 51.53(c)(3) as inapplicable to subsequent license renewal applicants is inconsistent with an "explicitly stated regulatory purpose" of Part 51—the promotion of efficient environmental reviews for license renewal applications.

c. *Agency Guidance*

In reaching its conclusion on section 51.53(c)(3), the Board also relied on agency guidance, which it appropriately accorded "special weight."[99] The Board noted that "[t]he Supreme Court has stated that an agency's interpretive statements 'reflect a body of experience and informed judgment to which courts and litigants may properly resort for guidance'" and that

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[95] *Id.* at 28,484.

[96] 10 C.F.R. § 54.17(c) ("An application for a renewed license may not be submitted to the Commission earlier than [twenty] years before the expiration of the operating license or combined license currently in effect.").

[97] *Id.* at 266 (citing 1996 Final Rule, 61 Fed. Reg. at 28,467).

[98] *Id.*

[99] *Id.* at 271 (quoting *Entergy Nuclear Operations, Inc.* (Indian Point, Units 2 and 3), CLI-15-6, 81 NRC 340, 356 (2015) (noting that guidance documents developed to assist in compliance with applicable regulations are entitled to special weight)).

"as such, they are entitled to a measure of respect."[100] The Board pointed to Supplement 1 to Regulatory Guide 4.2, which provides instructions for license renewal applicants for preparation of environmental reports.[101] The Board noted that Reg. Guide 4.2 "does *not* distinguish between initial and subsequent license renewal applicants" and that it "repeatedly states that issues 'identified as Category 1 issues in the GEIS . . . are adequately addressed for *all* applicable nuclear plants.'"[102] The Staff sought and received public comment on this Regulatory Guide as part of the revisions to the regulations in 2013.[103] We agree that our guidance supports the Board's interpretation of section 51.53(c)(3).

d. Future GEIS Updates

The Board pointed to the periodic reviews and updates to the GEIS mandated by Part 51 as further support for its interpretation of section 51.53(c)(3).[104] In the Board's view, periodic reviews and updates to the GEIS would not be necessary unless the Commission intended for all license renewal applicants going forward, as well as the Staff, to rely on the GEIS's generic findings rather than performing site-specific analyses of Category 1, as well as Category 2, issues.[105] We agree with the Board's conclusion and note that since the majority of initial license renewals occurred between 2000 and 2010, an ongoing obligation to update the GEIS

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[100] *Id.* at 271 n.41 (quoting *Holowecki*, 552 U.S. at 399).

[101] *Id.* (citing "Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications," Regulatory Guide 4.2, supp. 1, rev. 1 (June 2013) (ML13067A354) (Reg. Guide 4.2)).

[102] *Id.* (quoting Reg. Guide 4.2 at 25).

[103] *See* NRC Response to Public Comments Related to Draft Regulatory Guide DG-4015 (Proposed Revision 1 of Regulatory Guide 4.2, Supplement 1), Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications (June 20, 2013) (ML13067A355).

[104] LBP-19-3, 89 NRC at 267-68.

[105] *Id.* at 268.

every ten years would not promote the principles of economy and efficiency that the GEIS was supposed to further if it only applied to initial license renewals.

e. Licensing Experience

As discussed above, "[t]he NRC's review of a license renewal application proceeds along two independent regulatory tracks: one for safety issues and another for environmental issues."[106] We have made clear that "'license renewal should not include a new, broad-scoped inquiry into compliance that is separate from and parallel to [our] ongoing compliance oversight activity'" and that "operational matters . . . are appropriately addressed under the Staff's ongoing regulatory oversight process."[107] Our safety review of license renewal applications is based on detailed information that an applicant provides "to confirm whether the design assumptions used for the original licensing basis will continue to be valid throughout the period of extended operation."[108]

Similarly, our environmental analysis of license renewal is based on licensees' operating experience and our understanding of environmental impacts of operation. As noted previously, we based the framework of the environmental analysis for license renewal on the following factors: data from operating experience, the fact that environmental impacts of license renewal are expected to be bounded by data from operating experience given that license renewal is twenty additional years of continued operation, and our understanding that changes in the environment around nuclear plants are gradual and predictable.[109] For these reasons, the NRC has concluded that the environmental impacts from operation during a license renewal term

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[106] 2013 Final Rule, 78 Fed. Reg. at 37,282.

[107] *Prairie Island*, CLI-10-27, 72 NRC at 490-91 (quoting Nuclear Power Plant License Renewal; Final Rule, 56 Fed. Reg. 64,943, 64,952) (Dec. 13, 1991)).

[108] 2013 Final Rule, 78 Fed. Reg. at 37,282.

[109] 1996 Final Rule, 61 Fed. Reg. at 28,467-68.

would be similar to those during the current license term[110] and our site-specific environmental analysis of license renewal applications is limited to Category 2 issues—that is, those issues that would not "essentially be the same at all nuclear power plants."[111] In fact, this lengthy history of plant operation enabled us to make Category 1 findings in the first place.[112] Given that we and our licensees have amassed decades more operating experience since we first promulgated our 1996 Final Rule and that experience has been consistent with the assumptions underlying license renewal, we see no reason why subsequent license renewal should not be treated similarly. All of these factors support our understanding that the 2013 GEIS considered both initial and subsequent license renewal terms.

It should not be suggested that this approach allows the Staff to abrogate its responsibility to take a "hard look" at new and significant information.[113] The Staff retains its ongoing responsibility to analyze and incorporate into the SEIS any new and significant information regarding both Category 1 and Category 2 issues.[114] Licensees, petitioners, or other members of the public may also have information that would modify the analysis of a Category 1 issue for a subsequent license renewal in the 2013 GEIS either with respect to a specific facility or generically. Consequently, NRC regulations provide several mechanisms for the public to inform us of such information. Specifically, for general information, any person may file a petition for rulemaking to appropriately amend the codification of Category 1 issues in the

[110] 2013 GEIS at 1-2.

[111] 2013 Final Rule, 78 Fed. Reg. at 37,282.

[112] *Id.*

[113] *See Marsh*, 490 U.S. at 374.

[114] *See id.*

2013 GEIS.[115] With regard to a specific facility, members of the public may seek a waiver of our regulations to challenge the analysis in the 2013 GEIS on a Category 1 issue.[116] And perhaps most significantly, the Staff must update the GEIS on a ten-year cycle.[117] The agency has already begun pre-rulemaking activities to support this update, and the public will have an opportunity to comment as part of that rulemaking.[118] But, litigation in adjudicatory proceedings without a waiver is simply not one such mechanism; rather, "[a]djudicating category 1 issues site-by-site . . . would defeat the purpose of resolving generic issues in a GEIS."[119]

f. Response to the Dissenting Opinion

Commissioner Baran raises two challenges to this decision. First, he contends that the majority adopts "an unreasonable interpretation of 10 C.F.R. § 51.53(c)(3)."[120] Commissioner Baran would uphold the Petitioners' interpretation of 10 C.F.R. § 51.53(c)(3) because in his view "the plain and unambiguous language of the regulation limits its applicability to *initial* license renewal."[121] But we find the text of the regulation less clear. Section 51.53(c)(3) states that "[f]or those applicants seeking an initial renewed license . . . the environmental report shall include the information required in paragraph (c)(2) of this section subject to the following

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[115] 10 C.F.R. § 2.802.

[116] 10 C.F.R. § 2.335; *see also* 1996 Final Rule, 61 Fed. Reg. at 28,470 (noting that if the Staff receives information calling into question the validity of a Category 1 finding, either generically or with respect to a specific site, it will seek Commission approval to waive the rule as appropriate).

[117] 10 C.F.R. pt. 51, subpt. A, app. B.

[118] Planned Rulemaking Activities – Rules, https://www.nrc.gov/reading-rm/doc-collections/rulemaking-ruleforum/active/RuleIndex.html (last visited March 10, 2020).

[119] *Entergy Nuclear Vermont Yankee, LLC* (Vermont Yankee Nuclear Power Station), CLI-07-3, 65 NRC 13, 21 (2007).

[120] Commissioner Baran, Dissenting, at 1.

[121] *Id.* at 2.

conditions and considerations."[122] We agree that the plain language of section 51.53(c) requires environmental reports for an initial license renewal to address the provisions of subsection (c)(2) subject to the "conditions and considerations" in subsection (c)(3). But we do not agree that the regulation prevents subsequent license renewal applicants from doing the same. The regulation does not explicitly prohibit other license renewal applicants from also subjecting their environmental reports to those terms and conditions. Therefore, a literal reading of subsection (c)(3) does not bar applicants for subsequent license renewal from subjecting their environmental reports to the conditions and considerations in that subsection.

In contrast, the interpretation of section 51.53(c)(3) advanced by Commissioner Baran would require us to read more into the regulation than we find in its plain text. He claims, "[t]he explicit language of the regulation states that the provisions of 51.53(c)(1) and (c)(2) apply to all license renewal applicants, including those for subsequent license renewal, while section 51.53(c)(3) applies only to initial license renewal applicants."[123] But Commissioner Baran's analysis inserts the word "only" into section 51.53(c)(3). Therefore, we agree with the Board that a reasonable reading of the regulation is that it neither explicitly includes nor excludes subsequent license renewal applicants.[124]

Commissioner Baran's re-write of Part 51 would not stop at section 51.53(c). Rather than try to reconcile his reading of section 51.53(c)(3) with the rest of Part 51, he observes that "the regulatory direction to rely on the GEIS can only apply to the extent that the GEIS actually

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[122] 10 C.F.R. § 51.53(c)(3).

[123] Commissioner Baran, Dissenting, at 3.

[124] While Commissioner Baran invokes the doctrine of *expressio unius est exclusio alterius* to support his reading of section 51.53(c)(3), *id*., we agree with the Board's observation that this principle is not an "inflexible rule of law" but a starting point in regulatory construction, LBP-19-3, 89 NRC at 273.

evaluated the environmental impacts of subsequent license renewal. I find that it did not."[125] Thus, the dissent concludes that "the Category 1 findings in Table B-1 do not apply to subsequent license renewal applications."[126] However, this reading of Part 51 would similarly re-write Part 51 to limit Table B-1 to initial license renewals. Further, this interpretation also impacts sections 51.95(c) and 51.71(d), which build on Table B-1's incorporation of the findings in the 2013 GEIS. Consequently, we disagree with our colleague's interpretation of section 51.53(c)(3) because we conclude that it does not reconcile the regulation with the other provisions in Part 51.

Second, Commissioner Baran claims that the majority "mischaracterizes the scope of the GEIS."[127] Commissioner Baran asserts that "[n]either the original GEIS nor the 2013 GEIS revision analyzed the environmental impacts of subsequent license renewal periods."[128] He rejects the Board's conclusion that the 2013 GEIS applies to subsequent license renewals because he claims the Board relied "on some ambiguous statements in the text of the 2013 GEIS."[129] Again, we disagree. In reaching its conclusion, the Board cited the glossary in the 2013 GEIS.[130] The glossary defines "License renewal term" as "[t]hat period of time past *the original or current license term* for which the renewed license is in force."[131] This statement

[125] Commissioner Baran, Dissenting, at 6.

[126] *Id*. at 11.

[127] *Id.* at 1.

[128] *Id*. at 6.

[129] *Id*. at 10.

[130] LBP-19-3, 89 NRC at 270.

[131] 2013 GEIS at 7-27 (emphasis added).

indicates that the agency intended for the 2013 GEIS to cover initial and subsequent license renewals.

Commissioner Baran points to several other quotations from the 2013 GEIS and 1996 GEIS and supporting rulemaking documents for support.[132] We address much of this material above and acknowledge that some of it supports Petitioners' interpretation. Ultimately, like the Board, we find the definition of "License renewal term" in the 2013 GEIS itself is a more probative guide into understanding what license renewal terms the 2013 GEIS considered.

Finally, Commissioner Baran states that "[i]t would be a violation of NEPA for the agency to attempt to retroactively expand the scope of an environmental review completed seven years ago."[133] Because our interpretation of the 2013 GEIS rests on our review of contemporaneous statements regarding its scope, it is not a retroactive expansion. As a result, we disagree with our colleague that the agency's environmental review was inadequate for this license renewal.

For the reasons discussed above, we find that the regulatory history supporting Part 51 indicates that the NRC intended for the analysis of Category 1 issues in the 2013 GEIS to apply to subsequent license renewals. Because the primary purpose of section 51.53(c)(3)(i) is to enable applicants for license renewal to rely exclusively on the GEIS for Category 1 issues, our conclusion supports the proposition that section 51.53(c)(3) applies to subsequent license renewals. Thus, in response to the referred question, we agree with the Board that subsequent license renewal applicants may rely on the GEIS and thereby exclude consideration of Category 1 issues from their environmental reports, absent new and significant information that would change the conclusions in the GEIS.[134] Therefore, any challenge to Category 1 issues in

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[132] Commissioner Baran, Dissenting, at 7-10.

[133] *Id.* at 10.

[134] *See* 2013 GEIS at 1-4.

this or any other a subsequent license renewal proceeding would need to be accompanied by a rule waiver petition.[135]

III. CONCLUSION

For the foregoing reasons, we *dismiss* FPL's appeal; *accept* the Board's referral under section 2.323(f)(1) and *affirm* its ruling on the interpretation of section 51.53.

IT IS SO ORDERED.

For the Commission

NRC Seal

____
Annette L. Vietti-Cook
Secretary of the Commission

Dated at Rockville, Maryland,
this 23rd day of April 2020.

[135] *See* 10 C.F.R. § 2.335.

Additional Views of Chairman Svinicki and Commissioner Caputo

We fully join the majority's response to the referred question, whether the agency "intend[ed] to restrict section 51.53(c)(3) to initial license renewals."[1] Given the procedural posture of this case when the issue arose, litigating contention admissibility based on the analysis in the environmental report, the parties and Board's focus on this issue is understandable.[2] However, we write separately to emphasize that when considered in the larger context of our regulations, the answer to this referral does not resolve the more significant question of whether parties may litigate Category 1 issues in a subsequent license renewal proceeding without filing a waiver petition.

Petitioners presume that if section 51.53(c)(3) does not apply to subsequent license renewal applicants, then they may not rely on Category 1 issues in the 2013 GEIS. The above analysis assumes that Petitioners' premise is true and concludes that this position would lead to untenable results. But, fundamentally, Petitioners' premise is flawed. As explained below, even if section 51.53(c)(3) did not apply to subsequent license renewal applicants, our regulations would still allow subsequent license renewal applicants to rely on the 2013 GEIS's analysis of Category 1 issues and would prohibit challenges to those findings in adjudicatory proceedings absent a waiver.

Section 51.53(a) provides that "[a]ny environmental report prepared under the provisions of this section may incorporate by reference any information contained in a . . . final environmental document previously prepared by the NRC staff that relates to the production or utilization facility or site." That section specifically includes "NRC staff-prepared final generic environmental impact statements," such as the 2013 GEIS, in the list of documents that applicants may incorporate by reference into their environmental reports. Significantly,

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[1] LBP-19-3, 89 NRC at __ (slip op. at 25 & n.46).

[2] *Id*. at 269.

"incorporate by reference" is identical language to the phrase the Commission used to describe the effect of section 51.53(c)(3) on Category 1 issues when it was promulgated: "the analyses for certain impacts codified by this rulemaking need only be *incorporated by reference* in an applicant's environmental report for license renewal."[3] Consequently, regardless of the scope of 51.53(c)(3), our regulations already allow applicants for subsequent license renewal to rely on Category 1 findings in preparing their environmental reports.

Additionally, in reviewing subsequent license renewal reports environmental reports, the Staff will be guided by Table B-1 in Appendix B. Table B-1 applies to all license renewal proceedings through sections 51.71(d) and 51.95(c). As the United States Court of Appeals for the First Circuit has observed, "[b]ecause Category 1 issues have already been addressed globally by 10 C.F.R. pt. 51, subpt. A, app. B, they cannot be litigated in individual adjudications, such as license renewal proceedings for individual plants."[4] In other words, the codification of Category 1 issues rests in a different section of Part 51 than section 51.53(c). Therefore, even if Section 51.53(c)(3) did not apply to subsequent license renewal applicants, a contention regarding a Category 1 issue in a license renewal proceeding would still be a challenge to section 51.71(d), section 51.95(c), and Table B-1 and hence inadmissible without a waiver.[5]

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[3] 1996 Final Rule, 61 Fed. Reg. at 28,482 (emphasis added).

[4] *Massachusetts v. NRC*, 522 F.3d 115, 120 (2008).

[5] *See* 10 C.F.R. § 2.335.

Commissioner Baran, dissenting

I respectfully dissent from the majority opinion because it adopts an unreasonable interpretation of 10 C.F.R. § 51.53(c)(3) and mischaracterizes the scope of the agency's Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS). Contrary to the majority's assertions, Section 51.53(c)(3) does not apply to subsequent license renewal, and the GEIS did not evaluate the environmental impacts of subsequent license renewal. I would reverse the Board's ruling and hold that subsequent license renewal applicants and the NRC Staff may not exclusively rely on the GEIS and 10 C.F.R. Part 51, Subpart A, Appendix B, Table B-1 to evaluate environmental impacts of Category 1 issues.

I. INTERPRETATION OF SECTION 51.53(c)(3)

Section 51.53(c) requires an "applicant for renewal of a license to operate a nuclear power plant" to submit an environmental report with its application.[1] Section 51.53(c)(3) provides:

> For those applicants seeking an initial renewed license and holding an operating license, construction permit, or combined license as of June 30, 1995, the environmental report shall include the information required in paragraph (c)(2) of this section subject to the following conditions and considerations:
>
> (i) The environmental report for the operating license renewal stage is not required to contain analyses of the environmental impacts of the license renewal issues identified as Category 1 issues in appendix B to subpart A of this part.
>
> (ii) The environmental report must contain analyses of the environmental impacts of the proposed action, including the impacts of refurbishment activities, if any, associated with license renewal and the impacts of operation during the renewal term, for those issues identified as Category 2 issues in appendix B to subpart A of this part . . . .
>
> (iii) The report must contain a consideration of alternatives for reducing adverse impacts, as required by § 51.45(c), for all Category 2 license renewal issues in appendix B to subpart A of this part. No such consideration is required for Category 1 issues in appendix B to subpart A of this part.

[1] 10 C.F.R. § 51.53(c)(1).

(iv) The environmental report must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware.[2]

The Board majority found that this regulatory text does not answer the question of whether section 51.53(c)(3) can be applied to subsequent license renewal applicants, stating that "it neither directs the Commission to apply section 51.53(c)(3) to [subsequent license renewal] applicants, nor does it forbid the Commission from doing so."[3] In the Board's judgment, the Commission intended section 51.53(c)(3) to apply to all license renewal applicants, including those for subsequent license renewal.[4] According to the Board, FPL's environmental report did not need to consider Category 1 issues on a site-specific basis because it could rely on the Category 1 findings in the GEIS and Table B-1.[5]

I disagree with the Board's interpretation of section 51.53(c)(3) and would hold that the provision applies only to applicants for initial license renewal. The plain and unambiguous language of the regulation limits its applicability to *initial* license renewal. Statements in subsequent NRC documents that were not part of the notice and comment rulemaking process cannot change the explicit language of the regulation.[6]

Section 51.53(c)(1) applies to "[e]ach applicant for renewal of a license to operate a nuclear power plant under part 54," and section 51.53(c)(2) contains requirements for the

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[2] 10 C.F.R. § 51.53(c)(3).

[3] LBP-19-3, 89 NRC 245, 265.

[4] *Id.*

[5] *Id.* at 272-73.

[6] *See Perez v. Mortg. Bankers Ass'n*, 135 S.Ct. 1199, 1206 (2015) (citing *FCC v. Fox Television Stations, Inc.*, 566 U.S. 502, 515 (2009) (describing the Administrative Procedure Act's "mandate that agencies use the same procedures when they amend or repeal a rule as they used to issue the rule in the first instance").

environmental report that must be submitted by any such applicant.[7] By contrast, section 51.53(c)(3) narrows the scope of license renewal applicants to which it applies and speaks only of "those applicants seeking an *initial* renewed license and holding an operating license, construction permit, or combined license as of June 30, 1995."[8] Contrary to the Board's assertion, the regulation is not silent as to whether subsequent license renewal applicants can take advantage of the provisions of section 51.53(c)(3).[9] The explicit language of the regulation states that the provisions of 51.53(c)(1) and (c)(2) apply to all license renewal applicants, including those for subsequent license renewal, while section 51.53(c)(3) applies only to initial license renewal applicants. A basic canon of statutory construction is that the express mention of one thing excludes all others (*expressio unius est exclusio alterius*). When the regulatory text of section 51.53(c)(3) specifically addresses "those applicants seeking an initial renewed license," it is properly read as not addressing applicants seeking other license renewal terms.

The history of the rule provides additional support for the conclusion that section 51.53(c)(3) applies only to initial renewal applicants. In 1991, the NRC initiated the revisions to Part 51 that promulgated section 51.53. In the Statements of Consideration (SOC) for the proposed rule, the Commission explained that "the part 51 amendments apply to one renewal of the initial license for up to 20 years beyond the expiration of the initial license."[10] The final rule summarized the changes to the rule—none of which affect the scope stated in the proposed rule's SOC.[11] In fact, the SOC for the final rule, issued in 1996, stated that the final rule "is

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[7] 10 C.F.R. § 51.53(c)(1)-(2).

[8] *Id.* § 51.53(c)(3) (emphasis added).

[9] *See* LBP-19-3, 89 NRC at 265.

[10] Environmental Review for Renewal of Operating Licenses; Proposed Rule, 56 Fed. Reg. 47,016, 47,017 (Sept. 17, 1991) (1991 Proposed Rule).

[11] *See* 1996 Final Rule, 61 Fed. Reg. at 28,468-69.

consistent with the generic approach and scope of the proposed" rule.[12] Moreover, the final rule (as well as a subsequent 2007 version of the rule) retained the restriction that only "applicants seeking an *initial* renewal license" need not consider alternatives for reducing adverse environmental impacts for Category 1 issues in Table B-1.[13]

Later revisions to section 51.53, which were proposed in 2009 and finalized in 2013, did not remove the word "initial" in section 51.53(c)(3), despite making other changes to the subsection.[14] In fact, the SOC for the 2013 final rule revisions noted that the Atomic Energy Act authorizes the NRC to issue operating licenses for up to forty years and that the NRC regulations allow for renewal of these licenses for up to an additional twenty years.[15] Neither the proposed rule or final rule SOC mentioned subsequent license renewal periods.

Thus, the plain language of the regulation is clear that it applies only to applications for initial license renewal. However, FPL and the Staff argue that we may reject the plain meaning if it would produce an "absurd" result."[16] They contend that this exception to a basic canon of

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[12] *See* Environmental Review for Renewal of Nuclear Power Plant Operating Licenses; Final Rule, 61 Fed. Reg. 28,467, 28,468 (June 5, 1996).

[13] *Id.* at 28,487 (emphasis added). When section 51.53 was modified in 2007 to clarify its applicability to combined license applications, there was also a slight phrasing change from "those applicants seeking an initial *renewal* license" to "those applicants seeking an initial *renewed* license." *Compare id. with* Licenses, Certifications, and Approvals for Nuclear Power Plants; Final Rule, 72 Fed. Reg. 49,352, 49,513 (Aug. 28, 2007) (emphasis added). The 2007 amendments further support the plain language interpretation of the rule—if "initial" was not intended to be a restriction, the NRC had an opportunity to remove it while it was already revising the same phrase in 51.53(c)(3).

[14] Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses; Proposed Rule, 74 Fed. Reg. 38,117, 38,117 (July 31, 2009).

[15] 2013 Revisions, 78 Fed. Reg. at 37,282.

[16] *Applicant's Surreply to New Arguments Raised in Reply Pleadings* (Sept. 20, 2018), at 4 (FPL Surreply); *NRC Staff's Response to the Applicant's Surreply and the Petitioners' Response, Regarding the Applicability of 10 C.F.R. § 51.53(c)(3) to Subsequent License Renewal Applications* (Nov. 2, 2018), at 15-21 (Staff Response to FPL Surreply).

statutory construction applies because the NRC intended for the substantial efficiencies gained by the GEIS and codified in Table B-1 to apply to plants seeking subsequent license renewal.[17] I find this argument unpersuasive. As I discuss below, the GEIS did not address the environmental impacts of subsequent license renewal. Moreover, the GEIS still serves an important function for subsequent license renewal because the Staff may use the GEIS, through tiering and incorporation by reference, in its development of subsequent license renewal NEPA documents.

Similarly, the Board majority opined that it would be "nonsensical" to conclude that Part 51 authorizes the Staff to rely on the GEIS when preparing an SEIS but prohibits a subsequent license renewal applicant from doing so when preparing an environmental report.[18] The Board stated that Petitioners' interpretation of section 51.53(c)(3) is "incompatible with the purpose of an [environmental report], which is designed to aid the NRC Staff in preparing a draft SEIS," and "unambiguous regulations require [the Staff] to apply the GEIS to Category 1 issues" when the Staff drafts an SEIS for subsequent license renewal.[19] Specifically, the Board cited to sections 51.95(c)(4) and 51.71(d), and to Subpart A, Appendix B to Part 51 — regulatory language directing staff to integrate conclusions from, and rely on information found in, the GEIS. But the Board's conclusion rests on the inaccurate premise that the Staff could rely exclusively on the GEIS and Table B-1 when preparing an SEIS for subsequent license renewal. The regulatory direction to rely on the GEIS can only apply to the extent that the GEIS actually evaluated the environmental impacts of subsequent license renewal. I find that it did not.

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[17] FPL Surreply at 4; Staff Response to FPL Surreply at 19 & n.73.

[18] LBP-19-3, 89 NRC at 274.

[19] LBP-19-3, 89 NRC at 267 & n.35.

II. SCOPE OF THE GEIS

Neither the original GEIS nor the 2013 GEIS revision analyzed the environmental impacts of subsequent license renewal periods. The SOC for the 1991 proposed rule was very clear, stating that the GEIS would "characterize the nature and magnitude of impacts and other issues that will result from the refurbishments necessary for license renewal and the potential environmental impacts of operating plants for 20 years beyond their current 40-year licensing limit."[20] Additionally, in Appendix E—the appendix devoted to postulated accidents—the 2013 GEIS definitively states that its scope is limited to an initial period of license renewal:

> Since the NRC's understanding of severe accident risk has evolved since issuance of the 1996 GEIS, this appendix assesses more recent information on severe accidents that might alter the conclusions in Chapter 5 of the 1996 GEIS. This revision considers how these developments would affect the conclusions in the 1996 GEIS and provides comparative data where appropriate. This revision does not attempt to provide new quantitative estimates of severe accident impacts. In addition, *the revision only covers one initial license renewal period for each plant (as did the 1996 GEIS)*. Thus, the population projections, meteorology, and exposure indices used in the 1996 GEIS are assumed to remain unchanged for purposes of this analysis.[21]

The 1996 GEIS also stated that it "examines how [the currently operating commercial nuclear power] plants and their interactions with the environment would change if such plants were allowed to operate (under the proposed license renewal regulation 10 CFR Part 54) for a maximum of 20 years past the term of the original plant license of 40 years."[22] In addition, the 1996 GEIS contained an illustrative license renewal schedule, which contemplates an initial license and a single, renewed license: "The new license would go into effect at that point,

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[20] *Id.* at 47,020.

[21] 2013 GEIS, app. E, at E-2 (emphasis added).

[22] 1996 GEIS at 2-1.

covering the balance of the original 40-year term, as well as the additional 20-year term."[23] There was no mention of a potential subsequent license renewal term. Furthermore, in response to a comment on the draft rule related to decommissioning, the Commission stated that "[t]he analysis in the GEIS for license renewal examines the physical requirements and attendant effects of decommissioning after a 20-year license renewal compared with decommissioning at the end of 40 years of operation and finds little difference in effects."[24]

The 2013 GEIS also stated that it "documents the results of the systematic approach NRC used to evaluate the environmental consequences of renewing the licenses of commercial nuclear power plants and operating the plants for an additional 20 years beyond the current license term."[25] This statement of scope said nothing about subsequent license renewal terms. Similarly, in the section "Decisions to Be Supported by the GEIS," the 2013 GEIS focused solely on whether to renew operating licenses "for an additional 20 years."[26] Furthermore, in the discussion of the impacts of termination of operations and decommissioning with respect to land use, the 2013 GEIS stated, "[t]here would be no difference in offsite land use impacts whether decommissioning occurred at the end of its current 40-year operating license or following a 20-year license renewal term."[27]

FPL argues that the NRC's intent to review and update the GEIS and Table B-1 on a ten-year cycle does not make sense if their applicability was limited to initial license renewals.[28]

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[23] *Id.* at 2-36. This sixty-year schedule is supported by additional information in Appendix B to the GEIS, where the Staff also assumed a total plant life of sixty years. *Id.* at B-52.

[24] 1996 Final Rule, 61 Fed. Reg. at 28,482.

[25] 2013 GEIS at S-4.

[26] *Id.* at 1-7 to 1-8.

[27] *Id.* at 4-202.

[28] FPL Surreply at 6.

I disagree. It made sense to prepare for applications for initial license renewal submitted ten years or more after the Part 51 revisions were finalized in 1996. In fact, plants at thirty-three sites applied for initial license renewal in 2006 or later, with the most recent application submitted in 2017.[29] Therefore, updating the GEIS and Table B-1 served the important purpose of ensuring that the agency was relying on current information when preparing SEISs for initial license renewal applications that were submitted in 2006 or later.[30] Moreover, Table B-1 is a codification of the GEIS's findings, and its scope cannot be broader than the scope of the GEIS.

FPL and the Staff point to the regulatory cost-benefit analysis accompanying the 2013 GEIS to support their interpretation of the rule.[31] In that document, the Staff described prospective subsequent license renewal applicants as "affected licensees."[32] But the regulatory analysis is neither the rule nor the agency's NEPA environmental review. It cannot change the meaning of NRC's regulations or expand the scope of a NEPA review conducted by the Staff.

The Board relies on some ambiguous statements in the text of the 2013 GEIS to conclude that the GEIS analyzed the environmental impacts of subsequent license renewal.

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[29] NRC, Status of Initial License Renewal Applications and Industry Initiatives, https://www.nrc.gov/reactors/operating/licensing/renewal/applications.html (last visited Oct. 4, 2019).

[30] The preamble to Table B-1 states "[t]he Commission has assessed the environmental impacts associated with granting a renewed operating license for a nuclear power plant to a licensee who holds either an operating license or construction permit as of June 30, 1995." See 10 C.F.R. pt. 51, subpt. A, app. B. FPL argues that this language does not include the word "initial" before "renewed operating license," and that, therefore, it should be interpreted as applying to either initial or subsequent renewed operating licenses. *See* FPL Surreply at 3 n.9, 8. But in 1996, no applications for subsequent license renewal had been submitted or were even on the horizon. Twenty-two years later, FPL's application for Turkey Point was the first subsequent license renewal application. There was no need to specify in the appendix that Table B-1 only applied to "initial" license renewals because initial license renewals were the only type of renewal facing the agency in the foreseeable future.

[31] FPL Surreply at 11-12 (citing Regulatory Analysis at 25); Staff Response to FPL Surreply at 8-9, 11-12.

[32] Regulatory Analysis at 25.

But these isolated cases of ambiguous text are clearly outweighed by the numerous definitive statements in the GEIS that the document only examined the environmental impacts of a single, twenty-year license renewal. Even if the Staff had intended to address subsequent license renewal in the 2013 GEIS, the occasional ambiguous phrasing could not possibly put the public on notice of such an intention.[33] It is not reasonable to place the burden on the public to detect and divine the meaning of any ambiguities buried in the staff's NEPA document.

In sum, the 2013 GEIS did not evaluate the environmental impacts of subsequent license renewal. Referencing or building on this document could assist the Staff in preparing an EIS for Turkey Point's subsequent license renewal application, but the 2013 GEIS alone does not provide the required environmental review for operating a reactor beyond the initial twenty-year license renewal period. It would be a violation of NEPA for the agency to attempt to retroactively expand the scope of an environmental review completed seven years ago.

To be clear, the majority's retroactive expansion of the scope of the GEIS is essentially unlimited. The natural conclusion of the majority's flawed chain-of-reasoning is that "the GEIS covers the generic environmental impacts of all license renewals." If that were the case, the GEIS could be referenced to definitively address every Category 1 issue for a license renewal from 80 to 100 years, from 100 to 120 years, or even from 200 to 220 years. Yet, there is no basis to conclude that the Staff actually evaluated the environmental impacts of every potential future twenty-year license renewal term in the GEIS.

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[33] NEPA obligates an agency "to consider every significant aspect of the environmental impact of a proposed action," and to "inform the public that it has indeed considered environmental concerns in its decisionmaking process." *Baltimore Gas & Elec. Co. v. Nat. Res. Def. Council, Inc.*, 462 U.S. 87, 97 (1983). *See also* 40 C.F.R. § 1500.1(b) ("NEPA procedures must insure that environmental information is available to public officials and citizens before decisions are made and before actions are taken."); *id.* § 1502.1 ("[The EIS] shall provide full and fair discussion of significant environmental impacts and shall inform decisionmakers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment.").

Because the plain language of section 51.53(c) applies only to applications for initial license renewal and neither the original license renewal GEIS nor the 2013 GEIS revision evaluated the environmental impacts of subsequent license renewal, the Category 1 findings in Table B-1 do not apply to subsequent license renewal applications. As a result, Petitioners wishing to submit contentions related to topics addressed in Table B-1 should not need to submit petitions for rule waivers, even if the applicant or Staff incorporates the GEIS by reference.

III. THE BOARD'S CONTENTION ADMISSIBILITY DETERMINATIONS

Some of the Board's admissibility determinations in LBP-19-3 and LBP-19-8 turned on whether section 51.53(c)(3) applies to subsequent license renewal applications. With respect to any contentions, or portions thereof, that the Board excluded solely based on its interpretation of this regulation, the Commission should find those determinations to be in error. The Commission should remand this proceeding to the Board to consider any of the dismissed contentions, or portions thereof, that were dismissed for reasons related to the interpretation of section 51.53(c)(3).

IV. DIRECTION TO STAFF

Because the Staff cannot rely exclusively on Table B-1 to address the Category 1 environmental impacts of subsequent license renewal, the Commission should direct the Staff to ensure that the Final SEIS for the subsequent license renewal of Turkey Point meets the requirements of NEPA by adequately addressing the impacts of subsequent license renewal.

V. CONCLUSION

For these reasons, I respectfully dissent. I would *reverse* the Board's ruling on the interpretation of section 51.53(c); *remand* Petitioners' contentions to the Board for further consideration consistent with this decision; and *direct* the Staff to ensure that the Turkey Point SEIS complies with NEPA.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
FLORIDA POWER & LIGHT COMPANY	)	Docket Nos. 50-250-SLR
	)	50-251-SLR
(Turkey Point Nuclear Generating	)	
Units 3 & 4)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing **Commission Memorandum and Order (CLI-20-03)** have been served upon the following persons by Electronic Information.

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Office of the Secretary of the Commission

Dated at Rockville, Maryland,
this 23rd day of April 2020.

CERTIFICATE OF SERVICE

I certify that on October 30, 2020 I electronically filed the foregoing Deferred Joint Appendix with the Clerk of the Court for the United States Court of Appeals for the District of Columbia Circuit using the appellate CM/ECF system.

I certify that all participants in this case are registered CM/ECF users and service will be accomplished by the CM/ECF system.

October 23, 2020

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