United States Nuclear Regulatory Commission Official Hearing Exhibit
In the Matter of: Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3)
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3.0 ENVIRONMENTAL IMPACTS OF REFURBISHMENT

Environmental issues associated with refurbishment activities are discussed in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999).[1] The GEIS includes a determination of whether the analysis of the environmental issues could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, 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 collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(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.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required in this draft supplemental environmental impact statement (draft SEIS) unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1, and therefore, additional plant-specific review of these issues is required.

License renewal actions may include associated refurbishment actions that provide for safe and economic operation during the period of extended operation. These actions may have impacts on the environment that require evaluation, depending on the type of action and the plant-specific design.

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[1] The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

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3.1 Potential Refurbishment Activities

Entergy, in its environmental report, stated that its evaluation of structures and components required by Title 10, Section 54.21, "Contents of Application—Technical Information," of the *Code of Federal Regulations* (10 CFR 54.21), did not identify the need for refurbishment of structures or components for purposes of license renewal and that Entergy planned no such refurbishment activities (Entergy 2007). Entergy indicated that routine operational and maintenance activities would be performed during the license renewal period but that they were not refurbishment activities as described in the GEIS.

During the license renewal environmental scoping process, the staff of the U.S. Nuclear Regulatory Commission (NRC) received comments (Kaplowitz 2007; Shapiro 2007) indicating that Entergy had taken steps toward procuring replacement reactor vessel heads and control rod drive mechanisms (CRDMs) for Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3). The scoping comments indicated that an overseas firm plans to deliver replacement reactor vessel heads and CRDMs for IP2 and IP3 in October 2011 and October 2012, respectively. Based on this information, the staff requested, by letter to Entergy dated December 5, 2007, additional information regarding these potential refurbishment activities (NRC 2007).

Entergy's response, dated January 4, 2008, indicated that "no reactor vessel head replacements are required for purposes of aging management during the period of extended operation. Accordingly, no evaluation of the environmental impacts of reactor vessel head replacement as a refurbishment activity is required or presented in the Environmental Report." The response also stated that "the decision to proceed with procurement of long lead items [replacement vessel heads] is strictly economic" and therefore need not be addressed in Entergy's environmental report (Entergy 2008a).

During a telephone conference call on March 18, 2008 (NRC 2008a), the staff acknowledged that while there may be no requirement to replace the reactor vessel heads at IP2 and IP3 for license renewal, Section 2.6.1 of the GEIS discusses initiating actions for environmental impacts associated with license renewal. These actions include (1) refurbishment, repair, or replacement activities that "may be performed to ensure that this objective [aging management and maintaining functionality of certain SSCs] is achieved" and (2) activities that licensees may choose to undertake, including "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." Since the GEIS considers refurbishment activities beyond those that are related to aging management during the period of extended operation, the NRC staff indicated that Entergy's response to the staff's request for additional information (RAI) did not effectively address the staff's need for information about the potential refurbishment activities.

During the conference call, Entergy staff indicated that, if license renewal were not being pursued for IP2 and IP3, Entergy would not have ordered the vessel head forgings. Entergy also indicated that the vessel head forgings that were procured for IP2 and IP3 may never be needed at IP2 and IP3.

Given that Entergy has taken steps toward obtaining the replacement reactor vessel heads and

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CRDMs, and given that these replacement activities, should they occur, would be associated with license renewal (i.e., they would not be undertaken in the absence of license renewal), the NRC staff issued an additional RAI on April 14, 2008 (NRC 2008b), in which the staff requested information from Entergy regarding the process Entergy would use in deciding whether to replace the vessel heads and CRDMs, as well as indicating the potential environmental impacts of these replacement activities. Entergy submitted its response to NRC on May 14, 2008 (Entergy 2008b).

In its RAI response, Entergy reasserted that it did not believe vessel head and CRDM replacement constituted a refurbishment activity (Entergy 2008b). In addition, the response indicated that the current vessel heads are in good condition, though Entergy may eventually decide to replace them pending the results of future inspections.

Entergy's response also provided a likely hypothetical scenario for the replacement activities, should they occur. The scenario includes the following characteristics (Entergy 2008b):

- Approximately 250 additional workers would be required for the replacement of each reactor vessel head and CRDM. The replacement would take place during a 60-day refueling outage for each unit, when approximately 950 refueling outage workers are at the Indian Point site. An additional 50 workers would be required to construct the vessel head storage structure, though their work would be largely completed before the beginning of the refueling outage.
- The reactor vessel heads would be manufactured overseas, transported to a U.S. port, and shipped up the Hudson River via barge, with the CRDMs installed, to the existing IP barge slip.
- Once delivered to the IP2 and IP3 site, storage and preinstallation preparation would take place at onsite temporary structures. If possible, existing warehouses would also be used. The only permanent building constructed would be used to store the old reactor vessel heads and CRDMs; this building would likely be constructed near the onsite structure storing the old IP2 and IP3 steam generators and occupy less than 446 square meters (4800 square feet). All structures would be constructed on previously disturbed areas.
- Staff or contractors would cut a temporary opening in containment approximately 7.6 by 7.9 meters (26 feet by 25 feet) to allow for removal of the old heads and CRDMs and installation of the new ones. Containment concrete would be removed by hydro-demolition, while rebar and a portion of steel liner would be removed by other means.
- Before removing the old reactor vessel head from containment, Entergy would remove any loose contamination or affix it with a coating. The old head would then be transported to the onsite storage facility (for possible offsite permanent disposition). Meanwhile, the new head (with CRDMs) would be installed.
- Upon project completion, each unit's containment would be returned to its original configuration.

The NRC staff considered the GEIS guidance on refurbishment activities, the need to disclose

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potential impacts of the proposed action, and Entergy's analysis of possible impacts of vessel head and CRDM replacements. The NRC staff also acknowledged that vessel head and CRDM replacements may not occur. Nevertheless, to ensure that, should these refurbishment activities occur, their environmental impacts will have been characterized and disclosed in accordance with the National Environmental Policy Act and NRC implementing regulations, the NRC staff determined that it would be appropriate to evaluate the potential impacts of these possible replacement activities using the GEIS framework for refurbishment.

3.1 Refurbishment Impacts

The IP2 and IP3 site was one of seven case study reactor locations the NRC staff used in determining potential environmental impacts from refurbishment activities while developing the GEIS. After reviewing construction-stage impacts at these seven plant sites and then scaling them down to better approximate the duration and intensity of impacts expected during plant refurbishment activities, the NRC staff determined that nine refurbishment-related issues would be Category 1 issues. The GEIS approach to refurbishment assumed longer duration outages, more workers, and a wider array of activities on site than would occur during the reactor vessel head and CRDM replacement project discussed here. The GEIS also noted, in Appendix B, that outages would grow shorter as licensees gained experience with major replacement activities. Additionally, the GEIS noted that some licensees may choose to perform only a few activities.

Even given larger workforces, more activities, and longer outages, the NRC staff determined in the GEIS that the impacts for these nine issues are SMALL.

Table 3-1 contains a list of Category 1 issues associated with refurbishment.

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Table 3-1. Category 1 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
Surface Water Quality, Hydrology, and Use (for all plants)	
Impacts of refurbishment on surface water quality	3.4.1
Impacts of refurbishment on surface water use	3.4.1
Aquatic Ecology (for all plants)	
Refurbishment	3.5
Ground Water Use and Quality	
Impacts of refurbishment on ground water use and quality	3.4.2
Land Use	
Onsite land use	3.2
Human Health	
Radiation exposures to the public during refurbishment	3.8.1
Occupational radiation exposures during refurbishment	3.8.2
Socioeconomics	
Public services: public safety, social services, and tourism and recreation	3.7.4, 3.7.4.3, 3.7.4.4, 3.7.4.6
Aesthetic impacts (refurbishment)	3.7.8

Provided below are the results of the NRC staff reviews and a brief statement of GEIS conclusions, as codified in Table B-1 of 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," Subpart A, "National Environmental Policy Act—Regulations Implementing Section 102(2)," Appendix B, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," for each of the Category 1 refurbishment issues listed in Table 3-1. For each Category 1 issue, the NRC staff has not identified any new and significant information during its review of the Entergy environmental report (Entergy 2007), its site audit, the SEIS scoping process, and its evaluation of other available information, including Entergy's May 14, 2008, RAI response (Entergy 2008b).

- Impacts of refurbishment on surface water quality. Based on information in the GEIS, the Commission found the following:

  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. Based on information in the GEIS, the Commission found the following:

  Water use during refurbishment will not increase appreciably or will be reduced during plant outage.

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- Impacts of refurbishment on aquatic biota. Based on information in the GEIS, the Commission found the following:

  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.

- Impacts of refurbishment on ground water use and quality. Based on information in the GEIS, the Commission found the following:

  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.

- Impacts of refurbishment on onsite land use. Based on information in the GEIS, the Commission found the following:

  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.

- Radiation exposures to the public during refurbishment. Based on information in the GEIS, the Commission found the following:

  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. Based on information in the GEIS, the Commission found the following:

  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 risks from all causes including radiation is in the mid-range for industrial settings.

- Public services: public safety, social services, and tourism and recreation. Based on information in the GEIS, the Commission found the following:

  Impacts to public safety, social services, and tourism and recreation are expected to be of small significance at all sites.

- Aesthetic impacts (refurbishment). Based on information in the GEIS, the Commission found the following:

  No significant impacts are expected during refurbishment.

The NRC staff identified no new and significant information related to these issues during its review of the Entergy ER, during the SEIS scoping process, in correspondence identified in Section 3.1 of this chapter, or in Entergy's May 14, 2008, RAI response (Entergy 2008b). Therefore, the NRC staff expects that there would be no impacts during the renewal term

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beyond those discussed in the GEIS.

Environmental issues related to refurbishment considered in the GEIS for which these conclusions could not be reached for all plants, or for specific classes of plants, are Category 2 issues. These are listed in Table 3-2.

Table 3-2. Category 2 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53 (c)(3)(ii) Subparagraph
Terrestrial Resources		
Refurbishment impacts	3.6	E
Threatened or Endangered Species (for all plants)		
Threatened or endangered species	3.9	E
Air Quality		
Air quality during refurbishment (nonattainment and maintenance areas)	3.3	F
Socioeconomics		
Housing impacts	3.7.2	I
Public services: public utilities	3.7.4.5	I
Public services: education (refurbishment)	3.7.4.1	I
Offsite land use (refurbishment)	3.7.5	I
Public services, transportation	3.7.4.2	J
Historic and archeological resources	3.7.7	K
ENVIRONMENTAL JUSTICE		
Environmental justice	Not addressed[(a)]	Not addressed[(a)]

[(a)] Environmental justice is not addressed in the GEIS because Executive Order 12898 issued on February 11, 1994, and implementation guidance were not available prior to completion of the GEIS. Table B-1 of Appendix B, Part A of 10 CFR Part 51 indicates that this issue will be addressed in site specific reviews. The NRC staff groups Environmental Justice with Category 2 issues because the NRC staff addresses it in site specific reviews along with Category 2 issues.

The results of the review for each Category 2 refurbishment issue are provided in the following sections.

3.1.1 Terrestrial Ecology—Refurbishment Impacts

Refurbishment impacts on terrestrial ecology are a Category 2 issue (10 CFR Part 51, Subpart A, Appendix B, Table B-1). Table B-1 notes that "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

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proposal is presented with the license renewal application."

As stated in Section 4.4.5.2, Entergy has not proposed any new facilities, service roads, or transmission lines for IP2 and IP3 associated with continued operations or refurbishment. Entergy indicated, however, that it may replace the reactor vessel heads and CRDMs for IP2 and IP3 during the license renewal term. Ground-disturbing activities associated with this project would involve the construction of a storage building to house the retired components (Entergy 2008b). This area was previously disturbed by the construction of IP2 and IP3. Activities associated with the transport of the new reactor vessel heads and CRDMs would result in no additional land disturbance. The replacement components would arrive by barge and be transported over an existing service road by an all-terrain vehicle (Entergy 2008b). The route through which the service road passes was previously disturbed by the construction of all three IP units. Because Entergy plans to conduct all of these activities on previously disturbed land within a relatively short period of finite duration, the level of impact on terrestrial natural resources is expected to be SMALL.

Mitigation measures would include routine land and vegetation management practices, as well as using the most disturbed areas possible for new buildings and staging areas. The NRC staff did not identify any cost-benefit studies associated with these measures.

3.1.2 Threatened or Endangered Species—Refurbishment Impacts

Refurbishment impacts on threatened or endangered species are a Category 2 issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes the following:

> Generally, plant refurbishment and continued operation are not expected to adversely affect threatened and 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.

The NRC staff identified three federally listed terrestrial species—bog turtle, *Clemmys muhlenbergii*; New England cottontail, *Sylvilagus transitionalis*; and Indiana bat, *Myotis sodalist*—and one aquatic species—shortnose sturgeon, *Acipenser brevirostrum*—potentially affected by the relicensing of Indian Point. As explained above under Section 3.1.1, Entergy plans to conduct all terrestrial refurbishment activities on previously disturbed land within a relatively short period of finite duration. Entergy does not plan to conduct these activities on undisturbed land, and no designated critical habitat occurs on the site (Entergy 2008b). As a result, the NRC staff finds that refurbishment activities are not likely to adversely affect the continued existence of listed terrestrial species or adversely modify designated critical habitats.

Based on analyses presented in Section 4.6.1, shortnose sturgeon eggs and larvae probably do not occur, or occur only rarely, in the vicinity of Indian Point. Juvenile and adult shortnose sturgeon do occur in the vicinity of Indian Point. For refurbishment, the replacement components would arrive by barge and be transported over an existing service road by an all-terrain vehicle (Entergy 2008b). Entergy does not have plans to dredge to accommodate the barge at its dock and is not planning any other activities that would adversely affect aquatic species or habitats. Also, any onsite activities will have to follow existing regulations to control runoff from construction or industrial sites. Because no activities are planned that would

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adversely affect the aquatic environment, refurbishment activities are not likely to adversely affect the continued existence of endangered shortnose sturgeon.

Essential fish habitat, as defined under the 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act, occurs in the vicinity of IP2 and IP3 for red hake (*Urophycis chuss*) larvae, winter flounder (*Pleuronectes americanus*) larvae, windowpane (*Scophthalmus aquosus*) juveniles and adults, and Atlantic butterfish (*Peprilus triacanthus*) juveniles and adults. Because Entergy plans no refurbishment activities that would adversely affect the aquatic environment, there should be no adverse individual or cumulative effects on essential fish habitat in the project area.

3.1.3 Air Quality During Refurbishment (Nonattainment and Maintenance Areas)

Air quality during refurbishment (nonattainment and maintenance areas) is a Category 2 issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes the following:

> 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.

The May 14, 2008, RAI response from Entergy indicates that the replacement of reactor vessel heads and CRDMs for IP2 and IP3 will result in minor impacts to air quality. Citing the GEIS, Entergy states that the only potential sources of impacts to air quality would be (1) fugitive dust from site excavation and grading for construction of any new waste storage facilities and (2) emissions from motorized equipment and workers' vehicles.

Entergy indicates that the bulk of air quality impacts during the postulated refurbishment activity would result from exhaust emissions released by onsite motorized equipment and workers' vehicles (Entergy 2008b). These effects include temporary increases in atmospheric concentrations of nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), volatile organic compounds (VOC), ammonia, and particulate matter (PM).

A table summarizing the attainment status of the counties within the immediate area of IP2 and IP3 shows nonattainment of the National Ambient Air Quality Standards (NAAQS) for 8-hour ozone in Dutchess, Orange, Putnam, Rockland, and Westchester Counties. There is nonattainment of the NAAQS for $PM_{2.5}$ in Orange, Rockland, and Westchester Counties. Westchester County is designated as a maintenance county for CO.

Based on a conservative assumption that 400 additional vehicles would travel to and from the site each day during a 65-day outage period (conservative because Entergy projects that only 300 additional workers over 60 days could accomplish the replacement activities), Entergy estimated that air emissions of VOCs, CO, and NO_x would increase by 0.95 tons (0.86 metric tons (MT)), 16.1 tons (14.6 MT), and 1.02 tons (0.925 MT), respectively (Entergy 2008b). The regulatory conformity thresholds for VOCs, CO, and NO_x are 50 tons (45 MT), 100 tons (90.7 MT), and 50 tons (45 MT), respectively, as indicated in 40 CFR Part 51.853(b). A comparison of Entergy's conservative estimates for vehicle emissions versus the associated regulatory conformity levels indicates that none of the thresholds would be exceeded. Based on

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this analysis, the NRC staff finds that air quality impacts during the postulated reactor vessel head and CRDM replacement would be SMALL.

The NRC staff identified a variety of measures that could mitigate potential air quality impacts resulting from the vessel head and CRDM replacements at IP2 and IP3. These include the use of multiperson vans and carpooling policies to reduce the number of vehicles used to transport workers to the site. The NRC staff did not identify any cost-benefit studies applicable to these mitigation measures.

3.1.4 Housing Impacts—Refurbishment

Housing impacts during refurbishment are a Category 2 issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes the following:

> 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.

Entergy estimates that reactor vessel head and CRDM replacement would increase the number of refueling outage workers at the Indian Point site for up to 60 days during two separate refueling outages, one for each unit, 12 months apart. Approximately 250 workers would be needed for each replacement in addition to the normal number of refueling outage workers. An additional 50 workers would construct a storage structure for the old reactor vessel heads and CRDMs. This work would be completed before the beginning of the refueling outage (Entergy 2008b).

The number of additional workers would cause a short-term increase in the demand for temporary (rental) housing units in the region beyond what is normally experienced during a refueling outage at the Indian Point site. Since IP2 and IP3 are located in a high-population area (see Section 2.2.8.5) and the number of available housing units has either kept pace with or exceeded changes in county populations (see Section 2.2.8.1), any changes in employment would have no noticeable effect on the availability of housing in the socioeconomic region of influence. Because of the short duration of the replacement activity for each unit's reactor vessel head and CRDMs and the availability of housing in the region, employment-related housing impacts would have no noticeable impact.

3.1.5 Public Services: Public Utilities—Refurbishment

Public utilities is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes that "[a]n increased problem with water shortages at some sites may lead to impacts of moderate significance on public water supply availability."

Since there is no water shortage in the region and public water systems located in Dutchess, Orange, and Putnam Counties have excess capacity (indicated in Table 2-9 in Chapter 2), any changes in the Indian Point site and employee public water usage would have little noticeable effect on public water supply availability in these counties. As discussed in Section 2.2.8.2, the

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Indian Point site acquires potable water from the Village of Buchanan water supply system, and there are no restrictions on the supply of potable water from the village.

As discussed in Section 3.1.4, Entergy estimates that reactor vessel head and CRDM replacement would increase the number of refueling outage workers at the Indian Point site for up to 60 days during two separate refueling outages, one for each unit, 12 months apart (Entergy 2008b). The additional number of refueling outage workers needed to replace the reactor vessel heads and CRDMs would cause short-term increases in the amount of public water and sewer services used in the immediate vicinity of the Indian Point site. Since the region has excess water supply capacity with no restrictions, these activities would create no impacts.

3.1.6 Public Services: Education—Refurbishment

Education is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes that "[m]ost sites would experience impacts of small significance but larger impacts are possible depending on site- and project-specific factors."

As discussed in Section 3.1.4, Entergy estimates that reactor vessel head and CRDM replacement would increase the number of refueling outage workers for up to 60 days at the Indian Point site (Entergy 2008b). Because of the short duration of the replacement activity for each unit's reactor vessel head and CRDMs, workers would not be expected to bring families and school-age children with them; therefore, there would be no impact on educational services during this extended refueling outage.

3.1.7 Offsite Land Use—Refurbishment

Offsite land use is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes that "Impacts may be of moderate significance at plants in low population areas."

Since IP2 and IP3 are located in a high-population area, any changes in employment would have little noticeable effect on land use in the region. Because of the short duration of the replacement activity for each unit's reactor vessel head and CRDMs, the additional number of refueling outage workers would not cause any permanent changes in population and tax-revenue-related land use in the immediate vicinity of IP2 and IP3.

3.1.8 Public Services: Transportation—Refurbishment

Transportation is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes the following:

> 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.

The additional number of refueling outage workers and truck material deliveries needed to

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support the replacement of each reactor vessel head and CRDM would cause short-term level-of-service impacts on access roads in the immediate vicinity of the Indian Point site. According to Entergy, increased traffic volumes entering and leaving the Indian Point site during refueling outages, which occur at intervals of approximately 12 months for one unit or the other, have not degraded the level-of-service capacity on local roads, and the higher number of refueling outage workers during IP2 and IP3 steam generator replacement outages did not require any road improvements (Entergy 2008b). During routine periods of high traffic volume (i.e., morning and afternoon shift changes), Entergy has previously employed staggered shifts (starting and quitting times) during refueling outages to minimize level-of-service impacts on State Routes 9 and 9A (Entergy 2008b). Based on this information and because of the short duration of the replacement activity for each unit's reactor vessel head and CRDMs (up to 60 days), and given that the activity occurs at the same time as a normal refueling outage, the NRC staff finds that no transportation (level-of-service) impacts, beyond impacts from normal outages, would occur.

3.1.9 Historic and Archeological Resources—Refurbishment

Historic and archeological resources is a Category 2 refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes the following:

> 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.

As stated in Section 4.4.5.2, Entergy has not proposed any new facilities, service roads, or transmission lines for IP2 and IP3 associated with continued operations or refurbishment. However, Entergy indicated that it may replace the reactor vessel heads and CRDMs for IP2 and IP3 during the license renewal term. Ground-disturbing activities associated with this project would involve the construction of a storage building to house the retired components (Entergy 2008b). Should Entergy replace the vessel heads and CRDMs, ground-disturbing activities would be reviewed in accordance with Entergy Nuclear fleet procedures, which are designed to ensure that investigations and consultations are conducted as needed and that existing or potentially existing cultural resources are adequately protected (Enercon 2006). The procedures have been reviewed by the New York State Historic Preservation Office (NY SHPO). According to Entergy, the area of construction would be in an area that requires no prior consultation for historic, cultural, or archeological resources (Entergy 2008b). This area was previously disturbed by the construction of IP2 and IP3.

Activities associated with the transport of the new reactor vessel heads and CRDMs would result in no additional land disturbance. The replacement components would arrive by barge and be transported over an existing service road by an all-terrain vehicle (Entergy 2008b). The route through which the service road passes was previously disturbed by the construction of all three IP units.

The impacts associated with this activity are not expected to adversely impact historic or archeological sites in the area of IP2 and IP3. Therefore, the potential impacts from this activity on National Register-eligible historic or archeological resources would be SMALL. However, should archeological resources be encountered during construction, work would cease until

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Entergy environmental personnel would perform an evaluation and consider possible mitigation measures through consultation with the NY SHPO.

3.1.10 Environmental Justice—Refurbishment

Environmental justice is a plant-specific refurbishment issue. Table B-1 of Appendix B to 10 CFR Part 51, Subpart A, notes that "[t]he need for and the content of an analysis of environmental justice will be addressed in plant specific reviews."

Since IP2 and IP3 are located in a high-population area, the small, short duration change in employment associated with the potential replacement activities would likely have no noticeable effect on minority and/or low-income populations in the region. Because of the short duration of the replacement activity for each unit's reactor vessel head and CRDMs, and based on the analysis of impacts for the other resource areas discussed in Section 3.1, there would be no disproportionately high and adverse impacts to minority and low-income populations in the immediate vicinity of IP2 and IP3.

3.2 Evaluation of New and Potentially Significant Information on Impacts of Refurbishment

Entergy, in its May 14, 2008, RAI response (Entergy 2008b), indicated that it had reviewed the findings included in Chapter 3 of the GEIS and identified no new and significant information that would invalidate the findings made in the GEIS. Further, the NRC staff has reviewed Entergy's response, has evaluated the likely impacts of the vessel head and CRDM replacement, and has not identified any new and significant information associated with these activities.

3.3 Summary of Refurbishment Impacts

The NRC staff did not identify any information that is either new or significant related to any of the applicable Category 1 issues associated with replacement activities at IP2 and IP3 during the renewal term. The NRC staff concludes that the environmental impacts associated with those issues are bounded by the impacts described in the GEIS (NRC 1996). For each of the Category 1 issues addressed in this section, the GEIS concludes that impacts would be SMALL and that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

For all Category 2 issues related to replacement activities at IP2 and IP3, the NRC staff concluded—after reviewing guidance in the GEIS and Entergy's description of potential activities—that replacement activities would have SMALL or no impacts. The NRC staff's conclusions for Category 2 impact levels considered the activities' limited scope and duration compared to the refurbishment programs identified in the GEIS.

3.4 References

10 CFR Part 51. *Code of Federal Regulations*, Title 10, *Energy,* Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

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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."

Entergy Nuclear Operations, Inc. (Entergy). 2007. "Applicant's Environment Report, Operating 21 License Renewal Stage." (Appendix E of "IP2 and IP3, Units 2 and 3, License Renewal 22 Application"). April 23, 2007. Agencywide Documents Access and Management System (ADAMS) Accession No. ML071210530.

Entergy Nuclear Operations, Inc. (Entergy). 2008a. "Indian Point, Units 2 and 3—Reply to Request for Additional Information Regarding Environmental Review for License Renewal Application." January 4, 2008. ADAMS Accession No. ML080110372.

Entergy Nuclear Operations, Inc. (Entergy). 2008b. "Indian Point Units 2 & 3, Reply to Request for Additional Information Regarding License Renewal Application—Refurbishment." May 14, 2008. ADAMS Accession No. ML081440052.

Kaplowitz, Michael. 2007. Letter to Pao-Tsin Kuo, "Incompleteness and Inaccurate License Renewal Application for Indian Point Energy Center, Units 2 and 3." June 27, 2007. ADAMS Accession No. ML071990093.

Shapiro, Milton B. and Susan H. Shapiro. 2007. Letter to Pao-Tsin Kuo, "Comments on Scope of Environmental Impact Statement and Scoping Process Indian Point Energy Center Unit 2 and Unit 3." October 24, 2007. ADAMS Accession No. ML073100985.

U.S. Nuclear Regulatory Commission. 1996. "Generic Environmental Impact Statement for License Renewal of Nuclear Plants." NUREG-1437, Volumes 1 and 2. Office of Nuclear Regulatory Research, Washington, DC.

U.S. Nuclear Regulatory Commission. 1999. "Generic Environmental Impact Statement for License Renewal of Nuclear Plant." NUREG-1437, Volume 1, Addendum 1. Office of Nuclear Reactor Regulation, Washington, DC.

U.S. Nuclear Regulatory Commission. 2007. "Request for Additional Information Regarding Environmental Review for Indian Point Nuclear Generating Unit Nos. 2 and 3 License Renewal (TAC Nos. MD5411 and MD5412)." December 5, 2007. ADAMS Accession No. ML073330931.

U.S. Nuclear Regulatory Commission. 2008a. Summary of Telephone Conference Call between NRC and Entergy Nuclear Operations, Inc., Pertaining to the Indian Point Units 2 & 3, License Renewal Application—Environmental Request for Additional Information. April 9, 2008. ADAMS Accession No. ML080920983.

U.S. Nuclear Regulatory Commission. 2008b. "Request for Additional Information Regarding the Review of the License Renewal Application for Indian Point Nuclear Generating Unit Nos. 2 & 3 (TAC Nos. MD5411 and MD5412)." April 14, 2008. ADAMS Accession No. ML080940408.

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4.0 ENVIRONMENTAL IMPACTS OF OPERATION

Environmental issues associated with operation of a nuclear power plant during the renewal term are discussed in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999).[(1)] The GEIS includes a determination of whether the analysis of the environmental issues could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, 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 collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(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.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1 and, therefore, additional plant-specific review of these issues is required.

This chapter addresses the issues related to operation during the renewal term that are listed in Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51) and are applicable to Indian Point Nuclear Generating Units 2 and 3 (IP2 and IP3). In Section 4.1 of this draft supplemental environmental impact statement (SEIS), the U.S. Nuclear Regulatory Commission (NRC) staff addresses issues applicable to the IP2 and IP3 cooling systems. In Section 4.2, the NRC staff addresses issues related to transmission lines and onsite land use. In Section 4.3, the NRC staff addresses the radiological impacts of normal operations, and in Section 4.4, the NRC staff addresses issues related to the socioeconomic impacts of normal operations during the renewal term. In Section 4.5, the NRC staff addresses issues related to ground water use and quality, while the NRC staff addresses the impacts of renewal term operations on threatened and endangered species in Section 4.6. The NRC staff addresses potential new information in Section 4.7 and addresses cumulative impacts in Section 4.8. The results of the evaluation of environmental issues related to operation during the renewal term are summarized in Section 4.9. Finally, Section 4.10 lists the references for Chapter 4. Category 1 and Category 2 issues that are not applicable to IP2 and IP3 because they are related to plant design features or site characteristics not found at IP2 and IP3 are

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(1) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the GEIS include the GEIS and its Addendum 1.

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listed in Appendix F to this draft SEIS.

4.1 Cooling System

Generic (Category 1) issues in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 that are applicable to IP2 and IP3 cooling system operation during the renewal term are listed in Table 4-1. Entergy Nuclear Indian Point 2 and Entergy Nuclear Indian Point 3, LLC (Entergy) stated in its environmental report (ER) (Entergy 2007a) that it is not aware of any new and significant information associated with the renewal of the IP2 and IP3 operating licenses related to cooling system operation. The NRC staff has not identified any new and significant information related to cooling system operation during its independent review of the Entergy ER, the site visit, the scoping process, or the evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of the Category 1 issues, the NRC staff concluded in the GEIS that the impacts would be SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

A brief description of the NRC staff's review and the GEIS conclusions, as codified in 10 CFR Part 51, Table B-1, for each of these issues follows.

Table 4-1. Generic (Category 1) Issues Applicable to the Operation of the IP2 and IP3 Cooling System during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
SURFACE WATER QUALITY, HYDROLOGY, AND USE	
Altered current patterns at intake and discharge structures	4.2.1.2.1
Temperature effects on sediment transport capacity	4.2.1.2.3
Scouring caused by discharged cooling water	4.2.1.2.3
Eutrophication	4.2.1.2.3
Discharge of chlorine or other biocides	4.2.1.2.4
Discharge of sanitary wastes and minor chemical spills	4.2.1.2.4
Discharge of other metals in wastewater	4.2.1.2.4
Water-use conflicts (plants with once-through cooling systems)	4.2.1.3
AQUATIC ECOLOGY (ALL PLANTS)	
Accumulation of contaminants in sediments or biota	4.2.1.2.4
Entrainment of phytoplankton and zooplankton	4.2.2.1.1
Cold shock	4.2.2.1.5
Thermal plume barrier to migrating fish	4.2.2.1.6
Distribution of aquatic organisms	4.2.2.1.6
Premature emergence of aquatic insects	4.2.2.1.7
Gas supersaturation (gas bubble disease)	4.2.2.1.8

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Low dissolved oxygen in the discharge	4.2.2.1.9
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	4.2.2.1.10
Stimulation of nuisance organisms	4.2.2.1.11
HUMAN HEALTH	
Noise	4.3.7

The NRC staff reviewed information provided from the Entergy ER, the NRC staff's site visit, the scoping process, the New York State Pollutant Discharge Elimination System (SPDES) permits for IP2 and IP3 that expired in 1992 and the subsequent draft permit, ongoing Hudson River monitoring programs and their results, and other available information. The NRC staff has not identified any new and significant information for Category 1 issues applicable to the operation of the IP2 and IP3 cooling system during the period of extended operation.

Therefore, the NRC staff concludes that there would be no impacts for these issues during the renewal term beyond those discussed in the GEIS. The following bullets identify the Category 1 issues applicable to the operation of the IP2 and IP3 cooling system during the period of extended operation and the Commission's findings as indicated in the GEIS:

- Altered current patterns at intake and discharge structures. Based on information in the GEIS, the Commission found the following:

  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.

- Temperature effects on sediment transport capacity. Based on information in the GEIS, the Commission found the following:

  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. Based on information in the GEIS, the Commission found the following:

  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. Based on information in the GEIS, the Commission found the following:

  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.

- Discharge of chlorine or other biocides. Based on information in the GEIS, the Commission found the following:

  Effects are not a concern among regulatory and resource agencies, and are not

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expected to be a problem during the license renewal term.

- Discharge of sanitary wastes and minor chemical spills. Based on information in the GEIS, the Commission found the following:

  Effects are readily controlled through the NPDES permit[2] and periodic modifications, if needed, and are not expected to be a problem during the license renewal term.

- Discharge of other metals in wastewater. Based on information in the GEIS, the Commission found the following:

  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). Based on information in the GEIS, the Commission found the following:

  These conflicts have not been found to be a problem at operating nuclear power plants with once-through heat dissipation systems.

- Accumulation of contaminants in sediments or biota. Based on information in the GEIS, the Commission found the following:

  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. Based on information in the GEIS, the Commission found the following:

  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. Based on information in the GEIS, the Commission found 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 during the license renewal term.

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[2] NPDES stands for National Pollutant Discharge Elimination System; in the case of IP2 and IP3, it is issued by the New York State Department of Environmental Conservation (NYSDEC) and the NRC staff refers to it as an SPDES throughout this draft SEIS.

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- Thermal plume barrier to migrating fish. Based on information in the GEIS, the Commission found the following:

  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. Based on information in the GEIS, the Commission found the following:

  Thermal discharge may have localized effects but is not expected to affect the larger geographical distribution of aquatic organisms.

- Premature emergence of aquatic insects. Based on information in the GEIS, the Commission found the following:

  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). Based on information in the GEIS, the Commission found the following:

  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. Based on information in the GEIS, the Commission found the following:

  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. Based on information in the GEIS, the Commission found the following:

  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. Based on information in the GEIS, the Commission found the following:

  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

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plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.

- Noise. Based on information in the GEIS, the Commission found the following:

  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.

The NRC staff identified no new and significant information related to these issues during its independent review (including information provided from the Entergy ER, the NRC staff's site audit, the scoping process, the SPDES permits for IP2 and IP3 that expired in 1992 and the subsequent draft permit, ongoing Hudson River monitoring programs and their results, and other available information). Therefore, the NRC staff expects that there would be no impacts during the renewal term beyond those discussed in the GEIS.

The Category 2 issues (issues that the NRC staff must address in a site-specific review based on the framework established in the GEIS) related to cooling system operation during the renewal term that are applicable to IP2 and IP3 are discussed in the sections that follow and are listed in Table 4-2.

Table 4-2. Site-Specific (Category 2) Issues Applicable to the Operation of the IP2 and IP3 Cooling System during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(a)(3)(ii) Subparagraph	SEIS Section
AQUATIC ECOLOGY			
Entrainment of fish and shellfish in early lifestages	4.2.2.1.2	B	4.1.2
Impingement of fish and shellfish	4.2.2.1.3	B	4.1.3
Heat shock	4.2.2.1.4	B	4.1.4

For power plants with once-through cooling systems, the NRC considers the impingement and entrainment of fish and shellfish and thermal impacts from nuclear power plant cooling systems to be site-specific (Category 2) issues for license renewal. The NRC staff reviewed the applicant's ER (Entergy 2007a), visited the plant site, and reviewed the applicant's draft SPDES permit, fact sheets describing it, and the NYSDEC permit renewal process (NYSDEC 2003b). The NRC staff also reviewed relevant scientific publications, technical articles, and compilations associated with the study area, as well as documents and technical reports from NYSDEC, the National Marine Fisheries Service (NMFS), and other sources.

The SPDES permit for the Indian Point site, which addressed discharge from the currently operating IP2 and IP3, as well as the shutdown IP1 unit, expired in 1992 but has been administratively extended by NYSDEC. The NYSDEC proposed new SPDES permit for the site, currently in draft form, is in adjudication.

Section 316(b) of the Clean Water Act of 1997 (CWA) (Title 33, Section 1326, of the United States Code (33 USC 1326)) requires that the location, design, construction, and capacity of

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cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts. In the fact sheet for the site's draft SPDES permit, NYSDEC states that it has determined that the site-specific best technology available to minimize the adverse environmental impacts of the IP Units 1, 2, and 3 cooling water intake structures is closed-cycle cooling (NYSDEC 2003b). Under the terms of the proposed SPDES permit, NYSDEC (2003b) states that it will evaluate proposals from Entergy to institute alternative methods to avoid adverse environmental impacts. Given NYSDEC's statements in the proposed SPDES permit, the NRC staff decided to consider the environmental impacts that may occur if Entergy institutes closed-cycle cooling at IP2 and IP3—as well as the environmental impacts of a possible alternative method of reducing impacts to aquatic life—in Chapter 8 of this SEIS. In the following sections, the NRC staff addresses impacts from the current cooling system.

Applicant Assessment

In the draft environmental impact statement (DEIS) for the SPDES permits for IP2 and IP3, Roseton, and the Bowline Point generating stations (CHGEC et al. 1999), as well as in the IP2 and IP3 ER (Entergy 2007a), the plant owner or owners (IP2 and IP3 had separate owners in 1999) acknowledged that some impinged fish survive and others die. Mortality can occur immediately or at a later time. The DEIS examined impingement effects by evaluating conditional mortality rates (CMR) and trends (through 1997) associated with population abundance for eight selected taxa representing 90 percent of those fish species collected from screens at IP2 and IP3. These included striped bass, white perch, Atlantic tomcod, American shad, bay anchovy, alewife, blueback herring, and spottail shiner. Estimates of CMR, defined as the fractional reduction in the river population abundance of the vulnerable age group caused by a single source of mortality (in this case impingement) were assumed to be the same as or lower than that which occurred in the years before installation of modified Ristroph screens and fish return systems at IP2 and IP3 in 1991. For species exhibiting low impingement mortality (e.g., striped bass, white perch, and Atlantic tomcod), future impingement effects were expected to be substantially lower than they were before installation and use of modified Ristroph screens and fish return systems.

The Hudson River electric-generating utilities (CHGEC et al. 1999) estimated the maximum expected total impingement CMR for white perch and other taxa to quantify impact to the species. In the ER, Entergy (2007a) stated that the results of in-river population studies performed from 1974 to 1997 did not show any negative trend in overall aquatic river species populations attributable to plant operations. The ER also stated that ongoing population studies continued to support these conclusions. Thus, the applicant asserted that impingement impacts were SMALL and did not warrant further mitigation measures. In support of this assessment, the applicant provided two reviews (Barnthouse et al. 2002, 2008) in addition to the DEIS (CHGEC et al. 1999).

Regarding entrainment, the applicant concluded that population studies performed from 1974 though 1997 have not shown any negative trend in overall aquatic populations attributable to plant operations and that current mitigation measures will ensure that entrainment impacts remain SMALL during the license renewal term. Therefore, the applicant asserted (Entergy 2007a) that continued operation of once-through cooling at the site "does not have any demonstrable negative effect on representative Hudson River fish populations nor does it warrant further mitigation measures." Barnthouse et al. (2008) used an ecological risk assessment approach to evaluate the potential for adverse impacts to the representative

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important species (RIS) of the Hudson River from a variety of natural and anthropogenic stressors, including the operation of the IP2 and IP3 cooling water intake system, fishing pressure, the presence of zebra mussels, predation by striped bass, and water temperature. The authors concluded that operation of the IP2 and IP3 cooling met the NRC criteria for a SMALL impact level.

NYSDEC Assessment

Under the CWA, the U.S. Environmental Protection Agency (EPA) has delegated authority for the NPDES permit and Water Quality Certification programs in the State of New York to NYSDEC. The regulatory role of NYSDEC in the operation of the IP2 and IP3 cooling system includes protecting aquatic resources from impacts associated with impingement, entrainment, and thermal and chemical discharges through issuance of State (SPDES) permits and other means. The last SPDES permit for IP2 and IP3 expired in 1992, but its terms have been continued under provisions of the New York State Administrative Procedure Act. Regarding Section 316(b) of the CWA and New York Code, Rules and Regulations, Section 704.5 (6 NYCRR Section 704.5), NYSDEC (2003b) has determined that the site-specific best technology available to minimize the adverse environmental impact of the IP1, IP2, and IP3 cooling water intake structures is closed-cycle cooling.

In 2003, NYSDEC developed a final environmental impact statement (FEIS) (NYSDEC 2003a) in response to the DEIS submitted by the operators of IP2 and IP3, Roseton, and Bowline Point (CHGEC et al. 1999). In the FEIS, NYSDEC noted that "while the DEIS was acceptable as an initial evaluation and assessment, it was not sufficient to stand as the final document, and additional information as to alternatives and evaluation of impacts must be considered." In responding to public comments on the DEIS (CHGEC et al. 1999), NYSDEC noted that, in contrast to the utilities' assertions that the Hudson River fish community is healthy and robust, changes in "total species richness and diversity suggest that the Hudson estuary ecosystem is far from equilibrium." NYSDEC points out that the approach used by the utilities assumes "selected cropping" of individual fish species while "the impacts associated with power plants are more comparable to habitat degradation; the entire natural community is impacted" because entrainment, impingement, and warming of the water simultaneously affect the entire aquatic community of organisms. Emphasizing a more ecological approach, NYSDEC detailed the importance of food webs, trophic and other interspecies relationships, and ecosystem functioning.

NYSDEC (2003a) also stated that, while the changes to the IP2 and IP3 cooling system, including the use of dual-speed and variable-flow pumps and the installation of modified Ristroph traveling screens, "represent some level of improvement compared to operations with no mitigation or protection, there are still significant unmitigated mortalities from entrainment and impingement at all three of the Hudson River Settlement Agreement (HRSA) facilities." NYSDEC (2003a) concluded that the millions of fish killed by impingement, entrainment, and thermal effects at the HRSA power plants represent a significant source of mortality and stress on the Hudson River's fish community and must be taken into account when assessing the observed fish population declines. To help mitigate such losses, the NYSDEC (2003b) fact sheet for the SPDES permit states that "This permit does not require the construction of cooling towers unless: (1) the applicant seeks to renew its NRC operating licenses, (2) the NRC approves extension of the licenses, and determines that the installation and operation of closed-cycle cooling is feasible and safe, and (3) all other necessary Federal approvals are obtained."

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Furthermore, NYSDEC states that if the NRC grants extensions of the operating licenses, Indian Point would have to submit for NYSDEC approval a revised construction schedule for closed-cycle cooling.

NYSDEC, in Section 1, "Biological Effects," of Attachment B to the 2003 SPDES fact sheet (NYSDEC 2003b), states that operation of IP2 and IP3 results in the mortality of more than a billion fish of various lifestages per year and that losses are distributed primarily among seven species, including bay anchovy, striped bass, white perch, blueback herring, Atlantic tomcod, alewife, and American shad. Of these, NYSDEC indicates that the populations of Atlantic tomcod, American shad, and white perch are known to be declining in the Hudson River and considers current losses to be substantial.

Studies have also been conducted to detect trends of fish populations in the Hudson River. Both the applicant and NYSDEC have used the results of these studies to assess the potential for adverse effects associated with the operation of the IP2 and IP3 cooling system. The results of these assessments are described below. Some nongovernmental organizations (NGOs) and citizens have also evaluated publicly available information and data associated with the Hudson River and have expressed the opinion that many species of fish in the Hudson River are in decline and that the entrainment and impingement of all lifestages of fish and shellfish at IP2 and IP3 is contributing to the decline of these important aquatic resources.

NRC Assessment

Because the proposed SPDES permit (which includes NYSDEC's 316(b) determination regarding the cooling water intake structure) is still in draft stage and subject to ongoing adjudication, the NRC staff conducted an independent impact analysis for the purpose of addressing the Category 2 issues identified in Table 4-2 of this draft SEIS. The operation of the IP2 and IP3 cooling system can directly affect the aquatic communities of the Hudson River through impingement, entrainment, and thermal releases. Evaluating the potential for adverse impacts of the cooling system to the aquatic resources of the Hudson River estuary presents a significant challenge for three primary reasons:

(1) The potential stressor of interest (the IP2 and IP3 cooling system) occupies a fixed position on the Hudson River, while many of the RIS that the NRC staff have chosen for evaluation have the freedom to move up- and down-river during different stages in their growth and development, during different seasons of the year, and, in some cases, at different times of day.

(2) The Hudson River estuary is a dynamic, open-ended system containing a complex food web that extends from the freshwater portion of the river downstream of the Troy Dam to the Atlantic Ocean. Detectable changes in RIS populations may be influenced by natural stressors or may be the result of stressors associated with human activities, which include the operation of IP2 and IP3.

(3) Because the Hudson River estuary represents a complex system with hundreds of aquatic species, the NRC staff chose to focus its analysis of impact on a subset of RIS historically used to monitor the lower Hudson River (as indicated in Section 2.2.5.4 of this SEIS). By focusing on a subset of species that are representative of many of the species that exist in the lower Hudson River fish community, the NRC staff can more-easily analyze impacts to the Hudson River community, and the NRC staff can make use of a large body of sampling data compiled over many years. The NRC staff

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acknowledges that the simplification inherent in relying on RIS may introduce some additional uncertainty, but the NRC staff finds that the utility of the RIS approach (due to the availability of large, long-term data sets; applicability to species with similar characteristics; and comparability to other Hudson River studies) in evaluating communitywide effects outweighs the uncertainties associated with using it.

Because impingement and entrainment are fundamentally linked, the NRC staff determined that the effects of each should be assessed using an integrated approach, described in Section 4.1.3 of this draft SEIS. The NRC staff assessed thermal impacts separately in Section 4.1.4. Because the analysis of the environmental impacts associated with the IP2 and IP3 cooling system is complex, the NRC staff provides summary results, analyses, and conclusions in this chapter, and provides a complete discussion of the environmental impact assessment in Appendix H, with supporting statistical analyses in Appendix I to this draft SEIS.

4.1.1 Impingement of Fish and Shellfish

Impingement occurs when organisms are trapped against cooling water intake screens or racks by the force of moving water. Impingement can kill organisms immediately or contribute to a slower death resulting from exhaustion, suffocation, injury, or exposure to air when screens are rotated for cleaning. 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 screenwashing and fish return system that the plant operator uses. In this section, the NRC staff provides a summary assessment of impingement impacts based on NRC staff analyses of available data. More detail appears in Appendix H.

Impingement monitoring at IP2 and IP3 was conducted by former plant owners and their contractors between 1975 and 1990 using a variety of techniques. (A complete description of the impingement monitoring studies conducted at IP2 and IP3 appears in Appendix H to this draft SEIS.) The NRC staff assessment for the effects of cooling water system operation concentrated on 18 RIS identified in Section 2.2.5.4, which include the 17 species identified in the Hudson River utilities' DEIS (CHGEC et al. 1999) for assessing power plant effects plus the Atlantic menhaden (*Brevoortia tyranus*), a member of the herring family whose young are common inhabitants of the lower Hudson River. All but one RIS are fish; the exception is the blue crab (*Callinectes sapidus*). The estimated number of impinged RIS made up greater than 90 percent of all impinged taxa for all but 1 year at IP2 (Figure 4-1); at IP3, the estimated number of RIS impinged was greater than 85 percent for all but 1 year (Figure 4-2). To assess impingement impacts, the NRC staff analyzed weekly estimated impingement numbers at IP2 and IP3 from January 1975 to November 1980 and seasonally estimated impingement numbers from January 1981 to December 1990. (The former plant owners and their contractors based estimated numbers on sampling data.) The combined numbers of young of the year (YOY), yearling, and older fish were used for analysis since these data were available for all years of sampling.

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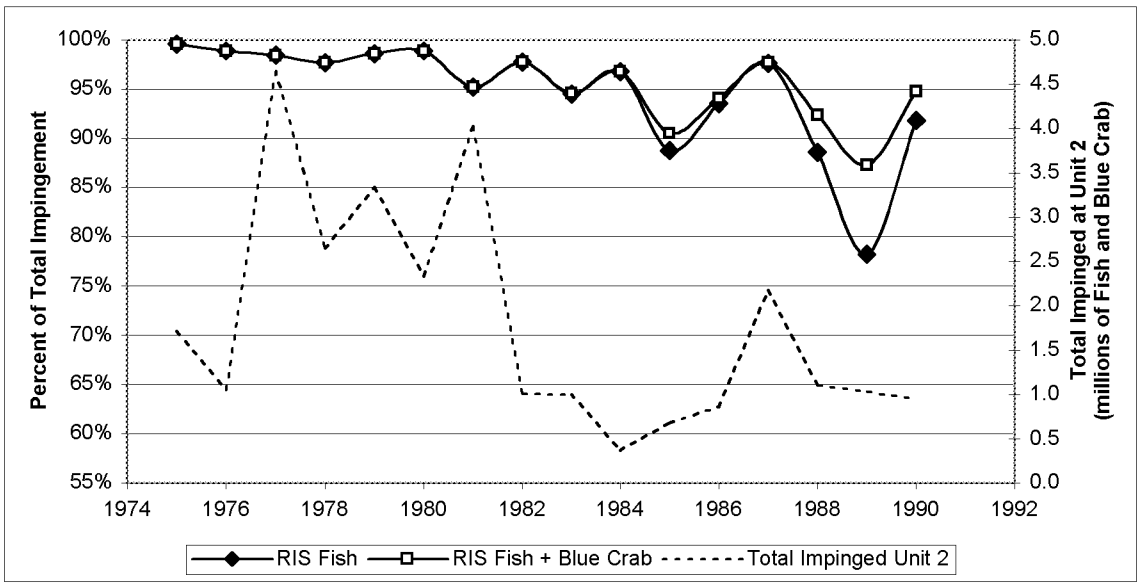

Figure 4-1. Percentage of impingement comprised of RIS fish and RIS fish plus blue crab in relation to the total estimated impingement at IP2 (data from Entergy 2007b)

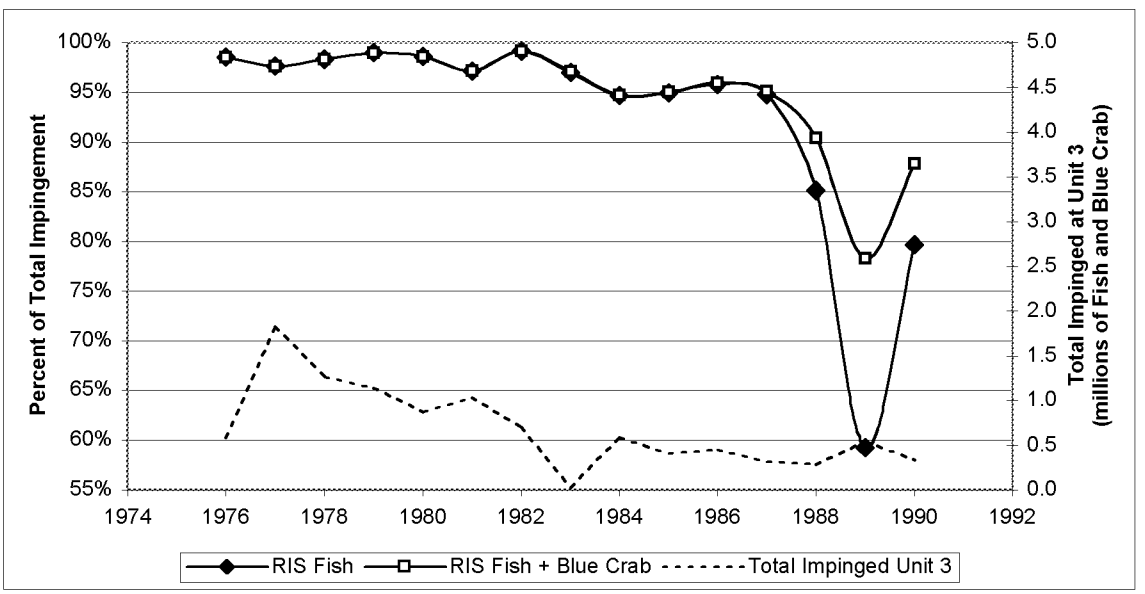

Figure 4-2. Percentage of impingement comprised of RIS fish and RIS fish plus blue crab in relation to the total estimated impingement at IP3 (data from Entergy 2007b)

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Total impingement trends at IP2 and IP3 suggest that the total number of fish and blue crab impinged tended to decrease between 1977 and 1982, then generally leveled off between 1982 and 1990 (as show in Figures 4-1 and 4-2). If the IP2 and IP3 cooling systems are considered a relatively constant sampler of Hudson River aquatic biota (recognizing the slight increase in days of operation and volume of water circulated at IP2 and IP3 from 1975 to 1990), then the decrease in the percent of RIS impinged and total impingement would suggest that RIS and all other taxa within the vicinity of IP2 and IP3 have decreased from a high in 1977 to a relatively constant lower level between 1984 and 1990. This decline will be explored further in Section 4.1.3 of this draft SEIS.

In addition to evaluating trends in impingement losses, the NRC staff also reviewed the results of studies designed to evaluate impingement mortality. Before installation of modified Ristroph screen systems in 1991, impingement mortality was assumed to be 100 percent. Beginning in 1985, pilot studies were conducted to evaluate whether the addition of Ristroph screens would decrease impingement mortality for representative species (see Appendix H for additional detail). The final design of the screens (Version 2), as reported in Fletcher (1990), appeared to reduce impingement mortality for some species based on a pilot study compared to the existing (original) system in place at IP2 and IP3. Based on the information reported by Fletcher (1990), impingement mortality and injury are lowest for striped bass, weakfish, and hogchoker, and highest for alewife, white catfish, and American shad (Table 4-3). The plant owners did not monitor impingement rates or validate impingement mortality estimates after the new Ristroph screens were installed at IP2 and IP3 in 1991.

Table 4-3. Assumed Cumulative Mortality and Injury of Selected Fish Species after Impingement on Ristroph Screens

Species	Percent Dead and Injured
Alewife	62
American Shad	35
Atlantic Tomcod	17
Bay Anchovy	23
Blueback Herring	26
Hogchoker	13
Striped Bass	9
Weakfish	12
White Catfish	40
White Perch	14

Source: Fletcher 1990

Based on Fletcher's assessment, the NRC staff concludes that the IP2 and IP3 cooling system continues to impinge RIS of the lower Hudson River and that impingement mortality for several species exceeds 25 percent. Monitoring data (Entergy 2007b, reviewed by NRC staff) also suggest that impingement is greater at IP2 than at IP3 and that impingement has generally declined since 1976. Although IP2 and IP3 currently employ modified Ristroph screens and fish

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return systems to increase the survival rates of impinged organisms, the actual improvements in fish survival after installation of these systems at IP2 and IP3 have not been established (impingement monitoring last occurred in 1990). In Section 4.1.3 of this draft SEIS, the NRC staff includes impingement results in a weight-of-evidence (WOE) analysis to evaluate the overall impacts of the IP2 and IP3 cooling system on lower Hudson River RIS.

4.1.2 Entrainment of Fish and Shellfish in Early Lifestages

Entrainment occurs when small aquatic life forms are carried into and through the cooling system during water withdrawals and primarily affects organisms with limited swimming ability that can pass through the screen mesh, which is typically 0.25 to 0.5 inch (in.) (6.35 to 12.7 millimeters (mm)), used on the intake systems. Organisms typically entrained include phytoplankton, zooplankton, and the eggs, larvae, and juvenile forms of many of the fish and invertebrates.

Once entrained, organisms pass through the circulating pumps and are carried with the water flow through the intake conduits toward the condenser units. They are then drawn through one of the many condenser tubes used to cool the turbine exhaust steam (where cooling water absorbs heat) and then enter the discharge canal for return to the Hudson River. As entrained organisms pass through the intake they may be injured from abrasion or compression. Within the cooling system, they encounter physical impacts in the pumps and condenser tubing; pressure changes and shear stress throughout the system; thermal shock within the condenser; and exposure to chemicals, including chlorine and residual industrial chemicals discharged at the diffuser ports (Mayhew et al. 2000). Death can occur immediately or at a later time from the physiological effects of heat, or it can occur after organisms are discharged if stresses or injuries result in an inability to escape predators, a reduced ability to forage, or other impairments.

Studies to evaluate the effects of entrainment at IP2 and IP3 conducted since the early 1970s employed a variety of methods to assess actual entrainment losses and to evaluate the survival of entrained organisms after they are released back into the environment by the once-through cooling system (see Appendix H for a more-detailed discussion). Despite increasingly refined study techniques, entrainment survival estimates were compromised by poor ichthyoplankton survival in control samples, and entrainment survival for many species is still unresolved. The variability of entrainment data informed the NRC staff's decision to employ a WOE approach.

To assess the effects of entrainment on the aquatic resources of the lower Hudson River, the NRC staff evaluated weekly average densities of entrained taxa for a given lifestage for IP2 and IP3 that were provided by the applicant. The NRC staff then multiplied the sum of the mean densities of all lifestages by the volume of circulated water to estimate the mean number entrained per taxa and season.

The NRC staff found that a total of 66 taxa were identified during entrainment monitoring in data supplied by Entergy (2007b). There were no blue crabs, shortnose or Atlantic sturgeon, or gizzard shad identified in the 1981–1987 entrainment data. Because of the difficulty in identification of early lifestages, RIS included those taxa that were identified only to family or genus (e.g., herring family, anchovy family, *Alosa* spp., and *Morone* spp.). The percent RIS fish entrained and the total entrainment are presented in Figure 4-3. Except for 2 weeks in 1984 and 1985 (1 week in May and 1 in June) for which amphipods (*Gammarus* spp.) were recorded,

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RIS represented at least 90 percent of all entrainment. The total number of identified fish entrained has decreased at a rate of 1.6 billion fish per year since 1984. This result is consistent with the decrease observed in the number of fish impinged (Figures 4-1 and 4-2).

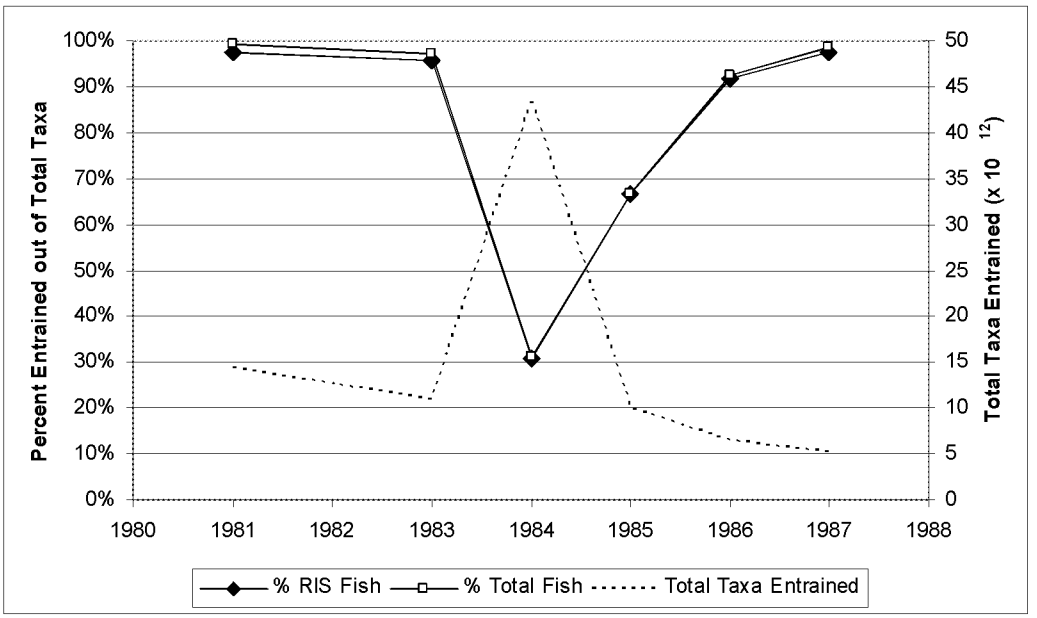

Figure 4-3. Percentage of entrainment comprised of RIS fish and total fish in relation to the total estimated entrainment at IP2 and IP3 combined (data from Entergy 2007b)

4.1.3 Combined Effects of Impingement and Entrainment

The NRC staff employed a modified WOE approach to evaluate whether the impingement and entrainment that occurs during the operation of the IP2 and IP3 cooling system has the potential to adversely affect RIS in the lower Hudson River. The term “weight of evidence” has many meanings, but it is defined by the NRC staff in this draft SEIS as an organized process for evaluating information or data from multiple sources to determine whether there is evidence to suggest that an existing or future environmental action has the potential to result in an adverse impact. The NRC staff employs a WOE approach adapted from the process described in Menzie et al. (1996). The overall approach is represented in Figure 4-4 and presented in detail in Appendix H to this draft SEIS; specific steps in the process are defined below.

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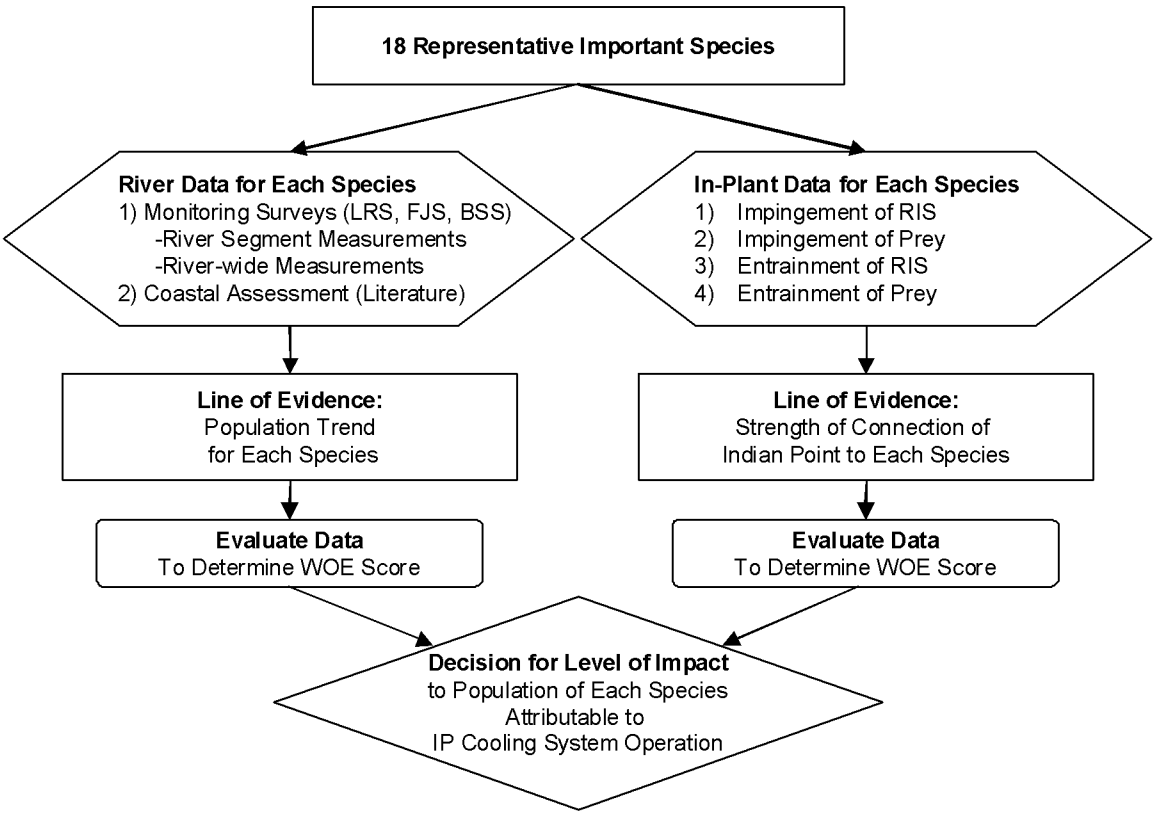

Figure 4-4. General weight-of-evidence approach employed to assess the level of impact to population trends attributable to IP cooling system operation

Step 1: Identify the Environmental Component or Value To Be Protected

For this assessment, the environmental component to be protected is the Hudson River aquatic resources as represented by the 18 RIS identified in Table 2-4. These species represent a variety of feeding strategies and food web classifications and are ecologically, commercially, or recreationally important. The WOE approach focuses primarily on the potential impacts to young-of-the-year and yearling fish and their food sources. The long-term sampling programs of the Hudson River, on which this analysis is based, focused on these early lifestages. Although eggs and larval forms are important components to the food web, the natural mortality to these lifestages is high. In contrast, fish surviving to the YOY stage and older are more likely to add to the adult breeding population and are at greater risk from the cooling system operation. Any factor that decreases (or increases) the survival of those fish during juvenile and yearling stages can affect the sustainability of the population.

Step 2: Identify Lines of Evidence and Quantifiable Measurements

The goal of this step is to identify data sets and information that can be used to assess the potential for adverse environmental effects and evaluate whether the IP2 and IP3 cooling system is contributing to the effect. The NRC staff developed two primary lines of evidence (LOE) to evaluate impacts. The first LOE included measurements of RIS population trends in the lower Hudson River and coastal areas to assess whether populations were increasing, decreasing, or stable; the second LOE addressed how much influence the operation of the IP2

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and IP3 cooling systems had on the RIS populations in the lower Hudson River (i.e., the strength of connection between IP2 and IP3 and the aquatic environment). The NRC staff used impingement and entrainment monitoring data obtained from the IP2 and IP3 facility; data from the lower Hudson River collected during the Long River Survey (LRS), Fall Juvenile/Fall Shoals Survey (FJS/FSS), and Beach Seine Survey (BSS), as described in Table 2-3 in the main text; and coastal fishery trend data, when available. A summary of measurements associated with each LOE is presented in Appendix H to this draft SEIS.

Step 3: Quantify the Use and Utility of Each Measurement

The following attributes of each measurement within each LOE were assigned an ordinal score corresponding to a ranking of its use and utility of low, medium, or high:

- Strength of Association: The extent to which the measurement is representative of, correlated with, or applicable to the RIS.
- Stressor-specificity: The extent to which the measurement is associated with a specific stressor or the extent to which the data used in the assessment relate to the stressor of interest.
- Site-specificity: The extent to which data used in the assessment relate to the site of interest.
- Sensitivity of the Measurement: The ability of the measurement to detect a response.
- Spatial Representativeness: The degree of compatibility between the study area and the location of measurements, known stressors, and biological receptors.
- Temporal Representativeness: The degree of compatibility between the measurement and the time period during which effects are expected to occur.
- Correlation of Stressor to Response: The degree of correlation between the levels of exposure to a stressor and levels of response observed in the measurement.

The NRC staff then calculated overall use and utility scores for each measurement within each LOE as the average of the individual attribute numbers. Scores for each LOE are available in Appendix H, Section H.3.

Step 4: Develop Quantifiable Decision Rules for Interpreting the Results of Each Measurement

Decision rules are used to assign a level of potential impact based on an analysis of the data. In support of the first LOE, the NRC staff developed decision rules that described a small, moderate, and large potential for adverse impact. Because the development and use of these rules is complex, a general definition of a small, moderate, and large potential for adverse impact is presented below. A detailed discussion of how the decision rules were developed and used in the environmental assessment is presented in Appendices H and I to this draft SEIS.

- A small potential for an adverse impact to a RIS population was determined if an analysis of available data suggested that a RIS population had remained stable over time and that the observed population levels were generally within the range of expected natural variability.

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- A moderate potential for an adverse impact to a RIS population was determined if an analysis of available data suggested that a RIS population was declining over time, OR that many of the observed population levels were outside the range of expected natural variability.
- A large potential for an adverse impact to a RIS population was determined if an analysis of available data suggested that the population was declining over time, AND that many of the observed population levels were outside the range of expected natural variability.

These decision rules were applied to each RIS species if sufficient data were available to support a determination. If sufficient data were not available, the NRC staff called the level of impact "unknown."

In support of the second LOE, which evaluated the strength of connection between the operation of the IP2 and IP3 cooling system and the RIS in the lower Hudson River, the NRC staff developed decision rules to assess whether the proportion of RIS present in impingement and entrainment samples obtained from IP2 and IP3 were similar to the proportions observed from the environmental sampling conducted in the lower Hudson River (e.g., the LRS, FJS/FSS, and BSS studies). The general definitions for each rule are presented below; a detailed discussion of decision rule development and use to assess strength of connection is presented in Appendices H and I to this draft SEIS.

- A low strength of connection was present if the proportional representation of a given RIS in the cooling system (entrainment and impingement samples) was less than the proportional representation obtained from the fishery studies, suggesting the RIS is underrepresented in the cooling system samples compared to the fishery studies.
- A medium strength of connection was present if the proportional representation of a given RIS in the cooling system samples was equal to the proportional representation observed in the fishery studies, suggesting the cooling system sample is equally representing the Hudson River population near IP2 and IP3.
- A high strength of connection was present if the proportional representation of a given RIS in the cooling system entrainment samples was greater than the proportional representation observed in the fishery studies, suggesting the cooling system sample is overrepresenting the Hudson River population near IP2 and IP3.

These decision rules were applied to each RIS species if sufficient data were available to support the determination. As described above, numerical scores were assigned to each impact level to facilitate integration.

Step 5: Integrate the Results and Assess Impact

The process used to integrate the two LOE and associated measurements brought together the assessment of population impacts and strength of connection derived from the use of the decision rules and the overall use and utility of each measurement with regards to decisionmaking. A detailed description of the process and statistical analysis employed is presented in Appendices H and I to this draft SEIS. The final determination of impact is

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consistent with the NRC guidelines for SMALL, MODERATE, and LARGE potential for adverse impacts 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—any important attributes of the resource.
>
> LARGE: Environmental effects are clearly noticeable and are sufficient to destabilize any important attributes of the resource.

What follows is the NRC staff assessment of the two LOE (population trends and strength of connection) and a determination of impact associated with impingement and entrainment at IP2 and IP3 using the above definitions.

4.1.3.1 Assessment of Population Trends—The First Line of Evidence

As described above, data from the LRS, FSS, and BSS studies of the lower Hudson River were used to assess population trends. Data from 1974 to 2005 were obtained from the applicant in electronic format. The NRC staff used an abundance index calculated by the applicant and calculated catch-per-unit-effort values where available. The NRC staff also evaluated coastal population trends for striped bass, American shad, Atlantic sturgeon, river herring, bluefish, Atlantic menhaden, and weakfish using commercial and recreational harvest statistics provided by the Atlantic States Marine Fisheries Commission (ASMFC).

To evaluate the population trend LOE, the NRC staff assessed population trends in river segment 4 (the region of the lower Hudson River encompassing IP2 and IP3), population trends in the lower Hudson River from the Troy Dam to the Battery, and the coastal trends reported by ASMFC. For each measurement, a WOE score was calculated, and a final WOE score was obtained. The results from this analysis appear in Appendix H to this draft SEIS and predict a moderate to large potential for adverse impacts for 13 of the 18 RIS. For two of these (Atlantic menhaden and Atlantic sturgeon) the moderate to large potential impact determination was based on only one LOE (coastal trends). The NRC staff predicts a small potential for adverse population-level impacts for blue crab based on only one LOE (coastal trends). The NRC staff could not reach an impact conclusion for gizzard shad because it was not a target species for the LRS, FSS, or BSS surveys. Likewise, NRC staff was unable to reach a determination of impact for the shortnose sturgeon because of a lack of available data for the YOY lifestage, the primary focus of the WOE assessment. Based on a lack of information for these species, the population trend LOE impact level could range from small to large. Population trends for year 1 and older Atlantic and shortnose sturgeon are presented in Section 4.6.1 of this draft SEIS based on electronic data provided by the applicant.

4.1.3.2 Assessment of Strength of Connection—The Second Line of Evidence

To determine whether the operation of the IP2 and IP3 cooling system had the potential to influence RIS populations near the facility or within the lower Hudson River, the NRC staff conducted strength of connection analyses. A summary of this analysis can be found in Appendix H, and detailed information on the analysis is presented in Appendix I to this draft SEIS.

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The strength of connection analysis assumes the IP2 and IP3 cooling system can affect aquatic resources directly through impingement or entrainment, or indirectly by impinging and entraining potential food (prey). By comparing the rank order of RIS caught in the river to the order observed in impingement and entrainment samples, it is possible to evaluate how efficient the IP2 and IP3 cooling system is at removing RIS from the river (e.g., how strongly it is connected to the RIS of interest). The results of this analysis are presented in Table 4-4 and show that a HIGH strength of connection was observed for only two species (bluefish and striped bass). For those species, the IP2 and IP3 cooling system was removing either the species or its prey at levels that were proportionally higher than what was observed in the river studies. This suggests that there is strong evidence that the operation of the cooling system is affecting these species. For the remaining RIS, the strength of connection ranged from low (minimal evidence of connection) to medium (some evidence of connection). The strength of connection was unknown for five species (Atlantic menhaden, Atlantic and shortnose sturgeon, gizzard shad, and blue crab) because of a lack of available data. For these species, actual strength of connection could be low, medium, or high, but the lack of data makes a specific determination impossible.

4.1.3.3 Impingement and Entrainment Impact Summary

The NRC staff presents the final integration of population-level and strength-of-connection LOE in Table 4-4. This table shows the final conclusions for both LOE (i.e., population trends and strength of connection). An adverse impact from IP2 and IP3 means that the data show both a measurable response in the RIS population and clear evidence that the RIS is influenced by the operation of the IP2 and IP3 cooling system. Thus, when the strength of connection is low, it is not possible to arrive at an impact level greater than SMALL because there is little evidence that a relationship between the cooling system and RIS exists. This logic also requires that for an RIS with a HIGH strength of connection to the IP2 and IP3 cooling system operation but little evidence of population decline, the final determination must also be SMALL.

Based on the final WOE assessment (available in Appendix H, Section H.3.3), a SMALL potential for adverse impact was predicted for two species (striped bass and weakfish) because there was no evidence of a population decline even though the strength of connection was MEDIUM or HIGH. A SMALL to MODERATE impact was predicted for seven species (alewife, bay anchovy, American shad, blueback herring, spottail shiner, Atlantic tomcod, and white catfish). A MODERATE impact was predicted for rainbow smelt, and a MODERATE to LARGE impact level was predicted for the hogchoker and white perch. A LARGE potential for adverse impact was predicted for only one species, the bluefish, based on observed population declines and an apparent HIGH strength of connection to the IP2 and IP3 cooling system. An impact determination could not be made for Atlantic menhaden, Atlantic and shortnose sturgeon, gizzard shad, and blue crab because of a lack of data for YOY lifestages, and therefore specific impacts are unknown and could range from SMALL to LARGE. The NRC staff addresses mitigation measures for these impacts in Section 4.1.5 of this draft SEIS.

The NRC staff assigns an overall impact level of SMALL to LARGE for impingement and entrainment to encompass the range of impacts for individual species. The RIS identified in this section are meant to represent the overall aquatic resource, express uncertainty from unquantifiable impact levels for some individual RIS, and reflect the complexity of the Hudson River ecosystem by encompassing a broad range of attributes, such as biological importance, commercial or recreation value, trophic position, commonness or rarity, interaction with other

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species, vulnerability to cooling system operation, and fidelity or transience in the local community. This range of impacts, then, expresses the impact to the overall aquatic community.

Table 4-4. Impingement and Entrainment Impact Summary for Hudson River RIS

Species	Population Line of Evidence	Strength of Connection Line of Evidence	Impacts of IP2 and IP3 Cooling System on Aquatic Resources
Alewife	Large	Low to Medium	Small to Moderate
Bay Anchovy	Moderate	Low to Medium	Small to Moderate
American Shad	Large	Low to Medium	Small to Moderate
Bluefish	Large	High	Large
Hogchoker	Large	Medium to High	Moderate to Large
Atlantic Menhaden	Moderate to Large	Unknown[(a)]	Unknown[(b)]
Blueback Herring	Large	Low to Medium	Small to Moderate
Rainbow Smelt	Large	Medium	Moderate
Shortnose Sturgeon	Unknown	Unknown[(a)]	Unknown[(b)]
Spottail Shiner	Large	Low to Medium	Small to Moderate
Atlantic Sturgeon	Large	Unknown[(a)]	Unknown[(b)]
Striped Bass	Small	High	Small
Atlantic Tomcod	Large	Low to Medium	Small to Moderate
White Catfish	Large	Low to Medium	Small to Moderate
White Perch	Large	Medium to High	Moderate to Large
Weakfish	Small	Medium to High	Small
Gizzard Shad	Unknown	Unknown[(a)]	Unknown[(b)]
Blue Crab	Small	Unknown[(a)]	Unknown[(b)]

[(a)]Strength of connection could not be established using WOE, therefore strength of connection could range from LOW to HIGH.
[(b)]Conclusion of impact could not be established using WOE, therefore impacts could range from SMALL to LARGE.

4.1.3.4 Discussion of Uncertainty

As part of reporting ecological risks, the EPA (1998) has recommended that practitioners review and summarize the major areas of uncertainty in their analyses. In this section, the NRC staff discusses the known uncertainties inherent with using the WOE approach.

As with any quantitative evaluation, the rigor of the analysis is dependent on the quality and source of data. The NRC staff acknowledges that the lack of studies and data on impingement and entrainment at IP2 and IP3 since 1990 and 1987, respectively, yields potential uncertainties for the staff's disposition of impingement and entrainment impacts using the WOE approach. The range and age of the data used is expected to introduce some inherent uncertainties (i.e., the current impacts, as described in Table 4-4, are inferred from impingement and entrainment data collected between 1975 and 1990). The NRC staff also notes that data collection for impingement and entrainment at Indian Point ended around the same time that the plant installed the modified Ristroph screens and fish return systems. Although it is expected that this

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system would likely have a positive effect on impingement mortality, there have been no additional data since 1990 to validate any impingement mortality estimates. More recent impingement and entrainment data, that reflect the effects of these plant modifications, could potentially affect the results of the Staff's WOE analysis; without such data, however, the NRC staff did not quantitatively incorporate this effect into the WOE approach. Nevertheless, as previously noted, the final design of the screens appeared to reduce impingement mortality for some species based on a pilot study compared to the original system in place at Indian Point (Fletcher 1990). The NRC staff did not include the results of this pilot study during or following the application of the WOE approach. As such, the NRC staff recognizes, in Appendix H, that the WOE results may potentially yield overestimates.

As previously noted, using the same data available to the staff with a different analytical approach, and affording consideration to the plant modifications which have been made, the applicant assessed impacts from impingement and entrainment as SMALL in its ER. The NYSDEC, however, while acknowledging that the Ristroph screens provide some improvements, expressed a continuing concern with respect to mortalities from impingement and entrainment. For these impacts, the NRC staff has independently chosen the use of the WOE approach to make its determination as quantitatively as possible, using available data.

The Massachusetts Weight-of-Evidence Workgroup (Menzie et al. 1996) discussed the value and use of both quantitative and qualitative approaches in development of the weight-of-evidence methodology. As recommended by the Workgroup (Menzie et al. 1996), NRC staff has used professional judgment to select and refine methods before analyzing data and documented all steps (see Appendices H and I) to allow interested readers to gain an understanding of the assumptions and limitations associated with this assessment. The NRC staff has also employed a similar methodology (Menzie et al. 1996), using other data, for assessing the effects of power plant operation on fish populations in its GEIS Supplement 22, regarding Millstone Power Station, Units 2 and 3 (NRC 2005).

In summary, the NRC staff's findings for impact from impingement and entrainment, as described in Table 4-4, are subject to the potential uncertainties described above to varying degrees. They also represent the NRC staff's best estimates based on the WOE derived from the available data.

4.1.3.5 Overall Impingement and Entrainment Impact

Based on the results of the NRC staff WOE analysis for RIS and the uncertainties discussed in the previous section, the NRC staff concludes that the overall impact to aquatic resources from impingement and entrainment ranges from SMALL to LARGE, depending on species affected.

4.1.4 Heat Shock

As discussed in Chapter 2, thermal discharges associated with the operation of the once-through cooling water system for IP2 and IP3 are regulated by NYSDEC. Temperature limitations are established and imposed on a case-by-case basis for each facility subject to 6 NYCRR 704.

Specific conditions associated with the extent and magnitude of thermal plumes are addressed in 6 NYCRR 704 as follows:

(5) Estuaries or portions of estuaries.

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(i) The water temperature at the surface of an estuary shall not be raised to more than 90 degrees Fahrenheit at any point.

(ii) At least 50 percent of the cross sectional area and/or volume of the flow of the estuary including a minimum of one-third of the surface as measured from water edge to water edge at any stage of tide, shall not be raised to more than four Fahrenheit degrees over the temperature that existed before the addition of heat of artificial origin or a maximum of 83 degrees Fahrenheit, whichever is less.

(iii) From July through September, if the water temperature at the surface of an estuary before the addition of heat of artificial origin is more than 83 degrees Fahrenheit an increase in temperature not to exceed 1.5 Fahrenheit degrees at any point of the estuarine passageway as delineated above, may be permitted.

(iv) At least 50 percent of the cross sectional area and/or volume of the flow of the estuary including a minimum of one-third of the surface as measured from water edge to water edge at any stage of tide, shall not be lowered more than four Fahrenheit degrees from the temperature that existed immediately prior to such lowering.

Thermal discharges associated with the operation of IP2 and IP3 are regulated under SPDES permit NY-0004472. This permit imposes effluent limitations, monitoring requirements, and other conditions to ensure that all discharges are in compliance with Title 8 of Article 17 of the Environmental Conservation Law (ECL) of New York State, 6 NYCRR 704, and the CWA. Specific conditions of permit NY-0004472 related to thermal discharges from IP2 and IP3 are specified in NYSDEC (2003b) and include the following:

- The maximum discharge temperature is not to exceed 110 degrees F (43 degrees C).
- The daily average discharge temperature between April 15 and June 30 is not to exceed 93.2 degrees F (34 degrees C) for an average of more than 10 days per year during the term of the permit, beginning in 1981, provided that it not exceed 93.2 degrees F (34 degrees C) on more than 15 days during that period in any year.

4.1.4.1 Potential Effects of Heated Water Discharges on Aquatic Biota

The discharge of heated water into the Hudson River can cause lethal or sublethal effects on resident fish, influence food web characteristics and structure, and create barriers to migratory fish moving from marine to freshwater environments. The potential for harm associated with the discharge of heated water into streams, rivers, bays, and estuaries became known during the early 1960s as new power facilities were being considered or constructed, and resulted in the definition of waste heat as a pollutant in the Federal Water Pollution Control Act of 1965. Waste heat discharges can directly kill sensitive aquatic organisms if the duration and extent of the organism's exposure exceeds its upper thermal tolerance limit. Indirect effects associated with exposure to nonlethal temperatures can result in disruptions or changes to spawning behavior, accelerated or diminished growth rates of early lifestages (both positive and negative), or changes in growth or survival in response to changes to food web dynamics or predator/prey interactions (CHGEC et al. 1999). Indirect effects can also occur if the presence of a thermal plume restricts or blocks a species' migratory pattern during a critical lifestage, or results in

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avoidance behavior that affects species' viability or increases the likelihood of predation.

Adverse thermal effects can also occur when thermal discharges are interrupted, resulting in cold shock. To evaluate the nature and extent of thermal discharges, it is necessary to have an understanding of the characteristics of the thermal plume when it enters the receiving water, the lethal and sublethal tolerance limits for key aquatic species and lifestages of interest, and the possible exposure scenarios (nature and extent). Thus, regulatory agencies tasked with developing thermal discharge criteria that are protective of aquatic resources (in this case, NYSDEC) generally set limits on the extent, magnitude, and duration of the thermal plume to ensure it addresses potential lethal and sublethal effects associated with the temperature of heated water discharged into the environment, and its characteristics when it enters receiving waters.

4.1.4.2 Historical Context

Thermal impacts associated with the operation of IP2 and IP3, Roseton, and the Bowline Point electrical generating stations have been a concern of NYSDEC, the NRC's predecessor organization (the U.S. Atomic Energy Commission (USAEC)), and the NRC. In the 1972 final environmental statement (FES) for the IP2 operating license (USAEC 1972), the USAEC concluded that, although operation of IP2 would meet New York thermal standards for river surface water temperature, there was evidence to suggest that the IP2 discharge could exceed New York State standards for surface area and cross-sectional area enclosed within the 4 degrees Fahrenheit (F) isotherm. USAEC, in response, issued an operating license for IP2 with the following conditions related to potential thermal impacts:

- operation of the once-through system would be permitted until January 1, 1978, and thereafter a closed-cycle system would be required;
- the applicant would perform an economic and environmental impact analysis of an alternative closed-cycle system, and provide the evaluation to the USAEC by July 1, 1973; and
- after approval by the USAEC, the required closed-cycle cooling system would be designed, built, and placed in operation no later than January 1, 1978.

The operating license also required the applicant to monitor dissolved oxygen in the discharge water and thermal plume, and monitor the size, shape, and locations of isotherms in the thermal plume (USAEC 1972). In the FES developed for the IP3 operating license, the NRC staff assessed the impact of thermal discharges from once-through cooling for all units (IP1, IP2, and IP3) and again concluded that, under certain conditions, the thermal discharges from the three units would exceed New York State thermal criteria (NRC 1975). The NRC issued an operating license to IP3 with conditions similar to those of IP2, but reflecting the decisions of the Atomic Safety and Licensing Board in 1974 that required closed-cycle cooling by May 1, 1979.

In 1976, the former owners of IP2 and IP3 submitted an environmental report to the NRC that evaluated various alternative closed-cycle cooling systems from an economic and environmental standpoint. In 1978, the former owners submitted a 316(a) determination to NYSDEC asserting that the facility complied with thermal standards established by New York State (6 NYCRR 704). In 1980, litigation associated with the operation of electric generation stations along the Hudson River resulted in the HRSA. In place of the cooling tower

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requirement, HRSA required a variety of mitigation measures including seasonal outages and the installation of dual-speed or variable-speed pumps at IP2 and IP3. The existence of HRSA also superseded the 1978 316(a) study. In support of the Fourth Amended Consent Order to HRSA (NYSDEC 1997), the owners of IP2 and IP3 developed flow efficiency curves for each unit that related flow to inlet temperature. For both units, flows of 500,000 gallons per minute (gpm) (1900 cubic meters per minute (m^3/min)) were generally attainable during the winter months (December–March when water inlet temperatures were less than 50 degrees F (10 degrees Celsius (C)), with flow rates of 700,000 gpm (2650 m^3/min) required during the summer months when inlet temperatures exceeded 70 degrees F (21 degrees C) (NYSDEC 1997, Figures B-1 and B-2). The Fourth HRSA Consent Order also developed a system of "flow variation points" as a means of evaluating changes in plant operations at IP2 and IP3, Bowline Point, and Roseton that offset exceedences of recommended flows with reductions at other times.

4.1.4.3 Thermal Studies and Conclusions

A detailed discussion of the thermal studies conducted at IP2 and IP3 to supplement the initial 316(a) work performed in the late 1970s is presented in CHGEC et al. (1999). The studies included thermal modeling of near-field effects using the Cornell University Mixing Zone Model (CORMIX), and modeling of far-field effects using the Massachusetts Institute of Technology (MIT) dynamic network model (also called the far-field thermal model). For the purpose of modeling, near field was defined as the region in the immediate vicinity of each station discharge where cooling water occupies a clearly distinguishable, three-dimensional temperature regime in the river that is not yet fully mixed; far field was defined as the region farthest from the discharges where the plumes are no longer distinguishable from the river, but the influence of the discharge is still present (CHGEC et al. 1999). The MIT model was used to simulate the hydraulic and thermal processes present in the Hudson River at a scale deemed sufficient by the utilities and their contractor and was designed and configured to account for time-variable hydraulic and meteorological conditions and heat sources of artificial origins. Model output included a prediction of temperature distribution for the Hudson River from the Troy Dam to the island of Manhattan. Using an assumption of steady-state flow conditions, the permit applicants applied CORMIX modeling to develop a three-dimensional plume configuration of near-field thermal conditions that could be compared to applicable water quality criteria (CHGEC et al. 1999).

Former owners of IP2 and IP3 conducted thermal plume studies employing both models for time scenarios that encompassed the period of June–September (CHGEC et al. 1999). These months were chosen because river temperatures were expected to be at their maximum levels. The former owners used environmental data from 1981 to calibrate and verify the far-field MIT model and to evaluate temperature distributions in the Hudson River under a variety of power plant operating conditions. They chose the summer months of 1981 because data for all thermal discharges were available, and because statistical analysis of the 1981 summer conditions indicated that this year represented a relatively low-flow, high-temperature summer that would represent a conservative (worst-case) scenario for examining thermal effects associated with power plant thermal discharges. Modeling was performed under the following two power plant operating scenarios to determine if New York State thermal criteria would be exceeded:

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(1) Individual station effects—full capacity operation of Roseton Units 1 and 2, IP2 and IP3, or Bowline Point Units 1 and 2, with no other sources of artificial heat.

(2) Extreme operating conditions—Roseton Units 1 and 2, IP2 and IP3, and Bowline Point Units 1 and 2, and all other sources of artificial heat operating at full capacity.

Modeling was initially conducted using MIT and CORMIX Version 2.0 under the conditions of maximum ebb and flood currents (CHGEC et al. 1999). These results were supplemented by later work using MIT and CORMIX Version 3.2 and were based on the hypothetical conditions represented by the 10th-percentile flood currents, mean low water depths in the vicinity of each station, and concurrent operation of all three generating stations at maximum permitted capacity (CHGEC et al. 1999). The 10th percentile of flood currents was selected because it represents the lowest velocities that can be evaluated by CORMIX, and because modeling suggests that flood currents produce larger plumes than ebb currents. The results obtained from the CORMIX model runs were integrated with the riverwide temperature profiles developed by the MIT dynamic network model to evaluate far-field thermal impacts (e.g., river water temperature rises above ambient) for various operating scenarios, the surface width of the plume, the depth of the plume, the percentage of surface width relative to the river width at a given location, and the percentage of cross-sectional area bounded by the 4 degrees F (2 degrees C) isotherm. In addition, the decay in excess temperature was estimated from model runs under near slack water conditions (CHGEC et al. 1999).

For IP2 and IP3, two-unit operation at full capacity resulted in a monthly average cross-sectional temperature increase of 2.13 to 2.86 degrees F (1.18 to 1.59 degrees C) for ebb tide events in June and August, respectively. The average percentage of river surface width bounded by the 4 degrees F (2 degrees C) temperature rise isotherm ranged from 54 percent (August ebb tide) to 100 percent (July and August flood tide). Average cross-sectional percentages bounded by the plume ranged from 14 percent (June and September) to approximately 20 percent (July and August). When the temperature rise contributions of IP2 and IP3, Bowline Point, and Roseton were considered collectively (with all three facilities operating a maximum permitted capacity and discharging the maximum possible heat load), the monthly cross-sectional temperature rise in the vicinity of IP2 and IP3 ranged from 3.24 degrees F (1.80 degrees C) during June ebb tides to 4.63 degrees F (2.57 degrees C) during flood tides in August. Temperature increases exceeded 4 degrees F (2 degrees C) on both tide stages in July and August. After model modifications were made to account for the variable river geometry near IP2 and IP3, predictions of surface width bounded by the plume ranged from 36 percent during September ebb tides to 100 percent during flood tides in all study months. On near-slack tide, the percentage of the surface width bounded by the 4 degrees F (2 degrees C) isotherm was 99 to 100 percent in all study months. The average percentage of the cross-sectional area bounded by the plume ranged from 27 percent (June ebb tide) to 83 percent (August flood tide) and was 24 percent in all study months during slack water events. These results suggest that the 4 degrees F (2 degrees C) lateral extent and cross-sectional criteria may sometimes be exceeded at IP2 and IP3. Exceedences generally occurred under scenarios that the applicants indicated may be considered quite conservative (maximum operation of three electrical generation facilities simultaneously for long periods of time, tidal conditions promoting maximum thermal impacts, atypical river flows). The steady-state assumptions of CORMIX are also important because, although the modeled flow conditions in the Hudson River would actually occur for only a short period of time when slack water conditions are replaced by tidal flooding,

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CORMIX assumes this condition has been continuous over a long period of time. CHGEC et al. (1999) found that this assumption can result in an overestimate of the cross-river extent of the plume centerline.

4.1.4.4 Assessments of Thermal Impacts

In this section, the NRC staff provides a summary of the various assessments of impacts associated with thermal discharges from the IP2 and IP3 cooling system. The applicant's assessment is based primarily on statements made in the ER (Entergy 2007a). The conclusions of NYSDEC concerning the thermal impacts of the IP2 and IP3 cooling system are presented in the final impact statement associated with the SPDES permits for Roseton Units 2 and 3, Bowline Units 1 and 2, and IP2 and IP3 (NYSDEC 2003a). The NRC staff also notes that NGOs and members of the public have expressed concern that the applicant's assessment of the effect of thermal discharges is incomplete, and that there is evidence to suggest that the existing thermal discharges do not consistently meet applicable criteria as defined in 6 NYCRR 704.2(b)(5).

Applicant's Assessment

The IP2 and IP3 ER (Entergy 2007a) discusses the potential environmental impacts of thermal discharges from IP2 and IP3. The conclusions provided in the ER acknowledge that the current owners of IP2 and IP3 hold a NYSDEC SPDES permit (NY-0004472) and that the station is complying with the terms of this permit. The conclusions of the ER also describe the current mitigation required under the terms of the Fourth HRSA Consent Order that include flow reductions to limit aquatic impacts and extensive studies in the Hudson River to evaluate temporal and spatial trends. The applicant concludes that "continued operation in the manner required by the current SPDES permit and the associated agreement to continue implementation of the fourth Consent Degree ensures that thermal impacts will satisfy the requirements of CWA 316(a) and will thus remain SMALL during the license renewal term. Therefore, no further mitigation measures are warranted" (Entergy 2007a).

NYSDEC Assessment

In the FEIS associated with the SPDES permits for Roseton Units 1 and 2, Bowline Point Units 1 and 2, and IP2 and IP3 (NYSDEC 2003a), NYSDEC concludes that "Thermal modeling indicates that the thermal discharge from IP2 and IP3 causes water temperatures to rise more than allowed, which is four degrees (F.) over the temperature that existed before the addition of heat, or a maximum of 83 °F, whichever is less, in the estuary cross sections specified in 6 NYCRR § 704.2(b)(5)."

According to NYSDEC (2003b), the last SPDES permit for the Indian Point facility expired in 1992, but its terms have been continued under provisions of the NY State Administrative Procedure Act. The fact sheet published by NYSDEC (2003b) in November 2003 describes the environmental and facility operational issues and permit conditions of the draft SPDES permit that NYSDEC has proposed to issue for IP2 and IP3. In Section IV, "Overview of the Permit" (Section B, "Thermal Discharges"), NYSDEC indicates that the permittee must satisfy the provisions of Section 316(a) of the CWA and related requirements in 6 NYCRR Section 704.2 "which provide that the thermal discharges from IP2 and IP3 to the Hudson River should meet regulatory temperature criteria for estuaries, and must meet the NYS standard of ensuring the propagation and survival of a balanced, indigenous population of shellfish, fish, and other

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aquatic species."

To meet this goal, NYSDEC requires, within the first 2 years of the SPDES permit term, that Entergy conduct a triaxial (three-dimensional) thermal study to document whether the thermal discharges associated with the operation of IP2 and IP3 comply with New York State water quality criteria. In the event the discharges do not comply, the permittee is allowed to apply for a modification of one or more criteria as provided by 6 NYCRR Section 704.4, but must demonstrate to the satisfaction of NYSDEC "that one or more of the criteria are unnecessarily restrictive and that the modification would not inhibit the existence and propagation of a balanced indigenous population of shellfish, fish, and wildlife in the Hudson River" (NYSDEC 2003a). In the ongoing proceeding before NYSDEC, Entergy has indicated that it would propose an alternative study. This matter is still under review before NYSDEC, and may not be resolved before NRC issues a final SEIS (Entergy 2006).

4.1.4.5 NRC Staff Assessment of Thermal Impacts

In the absence of the thermal study proposed by NYSDEC (or an alternative proposed by Entergy and accepted by NYSDEC), existing information must be used to determine the appropriate thermal impact level to sensitive lifestages of important aquatic species. Since NYSDEC modeling in the FEIS (NYSDEC 2003a) indicates that discharges from IP2 and IP3 could raise water temperatures to a level greater than that permitted by water quality criteria that are a component of existing NYSDEC permits, the staff must conclude that adverse impacts are possible. The NRC staff, after a review of available information on aquatic life in the Hudson River Estuary, did not find evidence of adverse effects on aquatic life that are clearly noticeable and sufficient to destabilize important attributes of an aquatic resource (the criteria for a LARGE finding). In the absence of specific studies, and in the absence of effects sufficient to make a determination of a LARGE impacts, the NRC staff concludes that thermal impacts from IP2 and IP# could thus range from SMALL to MODERATE depending on the extent and magnitude of the thermal plume, the sensitivity of various aquatic species and lifestages likely to encounter the thermal plume, and the probability of an encounter occurring that could result in lethal or sublethal effects. Additional thermal studies—as proposed by NYSDEC and Entergy—will generate data that could further refine or modify this impact level. For the purposes of this draft SEIS, the NRC staff concludes that impacts could range from SMALL to MODERATE.

4.1.5 Potential Mitigation Options

Potential mitigation options related to the operation of the IP2 and IP3 once-through cooling system are discussed in Chapter VII of the DEIS (CHGEC et al. 1999). Impacts associated with impingement were assumed by the Hudson River utilities to be adequately mitigated because previous IP2 and IP3 owners installed dual- and variable-speed pumps at IP2 and IP3, respectively, in 1994, and also installed modified Ristroph screens at both units in the early 1990s (CHGEC et al. 1999). The summary conclusion of the DEIS in 1999 was that the Hudson River utilities considered the system to be the best technology available to mitigate impingement losses (CHGEC et al. 1999). NYSDEC, however, has determined that closed-cycle cooling is the best technology available to protect aquatic resources (NYSDEC 2003b).

CHGEC et al. (1999) also discusses the mitigation of entrainment losses at IP2 and IP3 by ensuring that minimum flows are used for reactor cooling through the use of dual- or variable-speed pumps. In the ER (Entergy 2007a), the applicant concludes that, because impingement

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and entrainment are not having any demonstrable negative effects on Hudson River RIS, further mitigation measures are not warranted. NYSDEC's FEIS (2003a) indicated that "a range of available technologies exist to minimize aquatic resource mortality from the cooling water intake structures" at the Hudson River power plants, including IP2 and IP3. While NYSDEC indicated that IP2 and IP3 pump systems and modified Ristroph screens help mitigation impingement mortality, it also indicated that "significant unmitigated mortalities from entrainment and impingement" remain at all of the Hudson River power plants (NYSDEC 2003a).

The NRC staff, in the results of its analysis provided in Sections 4.1.3 and 4.1.4 of this draft SEIS, has found that impingement and entrainment from the operation of IP2 and IP3 are likely to have an adverse effect on aquatic ecosystems in the lower Hudson River during the period of extended operation. The available evidence suggests that the operation of the cooling systems directly affects RIS by impingement and entrainment, and indirectly affects these resources through the impingement and entrainment of their prey. The thermal discharges may also be influencing RIS, but the extent of this influence cannot be determined without further studies, such as those proposed in the draft SPDES permit for IP2 and IP3.

To assess potential mitigation options, the NRC staff reviewed the comments and responses provided in NYSDEC (2003a) and information provided by EPA in support of its Phase II 316(b) program (EPA 2008a). Based on this review, additional mitigation options that may be available for the existing cooling system include the following:

- additional flow reductions or planned outages
- use of wedgewire or fine-mesh screens
- use of barrier systems at the intake locations
- use of behavioral deterrent systems
- closed-cycle cooling using cooling towers (e.g., hybrid wet/dry mechanical draft towers)
- restoration

What follows is an overview of the effects of employing the above mitigation options to the existing system currently in operation at IP2 and IP3. Because NYSDEC indicated closed-cycle cooling is the best technology available for IP2 and IP3 (NYSDEC 2003b), the NRC staff will review a cooling tower alternative in Chapter 8, as well as an alternative that includes restoration with other mitigation measures intended to offset the effects of the existing once-through cooling system. Because the NRC staff will address them in greater depth in Chapter 8, closed-cycle cooling and restoration will not be addressed further in this chapter.

Costs and benefits of these measures have been addressed in the 1999 DEIS and evaluated by NYSDEC in the FEIS. Of these alternative options, NYSDEC received comments indicating that the cost figures for closed-cycle cooling in the DEIS were inflated by the Hudson River utilities. After reviewing cost data with consultants, however, NYSDEC indicated that costs were generally reasonable (noting that site-specific factors and changes in the cost of replacement power may affect cost estimates) (NYSDEC 2003a).

The measures the NRC staff addresses below and in Chapter 8, as well as any other measures to reduce entrainment and impingement at Indian Point, fall under the regulatory authority of NYSDEC and the powers delegated to it by the EPA under the CWA. While the NRC has no

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role in regulating or enforcing water quality standards, the NRC staff has included these mitigation measures in the interest of fulfilling the NRC's obligations under the National Environmental Policy Act (NEPA) (42 USC 4321, et. seq) and 10 CFR Part 51.

Additional Flow Reductions or Shutdowns

As discussed in Section 4.1.1.1 of this draft SEIS, under the conditions of HRSA and the subsequent consent orders, the operators of IP2 and IP3 developed programs to employ flow-reduction measures and scheduled outages to reduce impingement and entrainment impacts. Because flow rates were dependent on water temperature, greater flows were required during the months of May through October when river water temperatures were above 15 degrees C. It may be possible to further reduce flows or increase the length or frequency of scheduled outages, though these options will cause the plant operator to lose revenue from operating IP2 and IP3. In the 1999 DEIS, CHGEC et al. estimated that outages could cost between $14 million and $73 million per year.

Wedgewire or Fine-Mesh Screens

In some cases, the use of wedgewire or fine-mesh screens has shown potential for decreasing entrainment at once-through powerplants. Wedgewire screens typically have a screen size of 0.5 to 10 mm and are designed to reduce entrainment by physical exclusion and exploiting hydrodynamic patterns (EPA 2008). Fine-mesh screens generally employ a mesh size of 0.5 mm or less, and reduce entrainment by gently trapping organisms and reintroducing them back into the environment via plant-specific collection and transfer systems. Factors influencing the use of this technology include the screen size, the location and configuration of the system relative to the intake, the intake flow rates, the presence and magnitude of a "sweeping" current that can limit impingement or move organisms past the screen into safe water, and the size of the organism present near the intake. In its evaluation of wedgewire and fine-mesh screens, EPA (2008a) indicated that these technologies showed promise for reducing entrainment, but expressed concerns about the maintenance required to prevent clogging and the potential for this technology to reduce entrainment but increase impingement. EPA (2008a) considered the use of wedgewire screen technology to be more suitable for use in closed-cycle makeup water systems where lower flow rates exist and fewer screens are required.

Because the portion of the Hudson River near IP2 and IP3 is subject to tidal influence, there are periods of time when a sweeping current is not present. During this time, impingement against wedgewire or fine-mesh screen systems would be exacerbated. Although the use of these technologies at IP2 and IP3 is possible, numerous technical challenges would exist, including how to configure and clean the screens, how to evaluate capture and removal success, and how to assess the environmental effects and tradeoffs that would occur when one type of impact (entrainment) is reduced while another impact (impingement) may increase. CHGEC estimated that wedgewire screens could cost $44 million to $55 million per year in lost electricity production, and indicated that fine-mesh screens would not be feasible.

Barrier Systems

Gunderboom® and Marine Life Exclusion System™ (MLES™) technologies provide additional exclusion of entrainable-sized organism from cooling systems. Nets or screens are deployed during peak periods of entrainment to reduce overall entrainment. Gunderboom technology has been evaluated at the Lovett fossil fuel generating station since 1994. The system deployed in 2000 consisted of a two-ply fabric 500 feet (ft) (150 meters (m)) long, with a surface area of

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8000 square feet (ft^2) (743 square meters (m^2)), and equipped with 500-micrometer (0.020 in.) perforations. The system extended to a depth of 20–30 ft (6.1–9.1 m) and was held in place with anchors. An automated airburst system with strain gages and head differential monitors was used to release compressed air at depth to clean the screens. The preliminary results from the 2000 deployment documented by Raffenberg et al. (2008) suggested that the system resulted in an 80-percent reduction in ichthyoplankton entering the facility, and that periodic elevated densities of ichthyoplankton inside the barrier were linked to breaches of the system. Impingement investigations suggested that eggs did not adhere to fabric, and mortality was below 2 percent in laboratory studies. Based on observational data, larvae did not orient toward the flow, and did not impinge on the fabric with a through-fabric velocity of 5 gallons per minute per square foot or 0.20 meters per minute (Raffenberg et al. 2008).

The use of barrier systems may be feasible at IP2 and IP3 as a mitigation action, but further study may be needed to determine the long-term impacts of these systems. CHGEC et al. (1999) indicated that barrier nets or fine-mesh barrier nets would not be feasible at Indian Point, and did not assign a cost. EPA (2008), however, has indicated that barrier systems like Gunderboom show significant promise for minimizing entrainment, but still considers the technology "experimental in nature." Some advantages of the systems are that they can be deployed, retrieved, and replaced seasonally as needed. They are suitable for use in all types of water bodies and appear to reduce entrainment and impingement losses. The disadvantages are related to the limited number of long-term studies available to assess the performance of the technology, the durability of the systems in high-energy areas, the level of maintenance and monitoring required, the effects of biofouling on system performance, and the large volume of water that IP2 and IP3 withdraw. Additionally, it may be necessary to determine whether potential safety issues associated with the deployment of the systems at a nuclear generating station can be addressed.

Behavioral Deterrent Systems

Behavioral deterrent systems such as noncontact sound barriers or the use of light sources to reduce impingement have been evaluated at a variety of power generating stations in marine, estuarine, and freshwater environments (EPA 2008a). At present, a sonic deterrent system is being used at the Danskammer Point fossil energy plant on the Hudson River, and a similar system has been evaluated at Roseton. The advantage to these systems is that they can be configured and deployed at a variety of locations at costs that are not prohibitively high for simple system configurations. The disadvantages of the systems are that pneumatic air guns, hammers, and fishpulser systems are not considered reliable, the cost of sophisticated acoustic sound-generating systems can be high, and the use of high-technology equipment requires maintenance at the site (EPA 2008a). EPA (2008a) further states that, although many studies have been conducted to evaluate the feasibility of sound and light to reduce impingement and entrainment, the results "have either been inconclusive or shown no tangible reduction in impingement or entrainment" (EPA 2008a). There is, however, evidence that the use of acoustic sound barriers at a site in Pickering, Ontario, did appear to reduce the impingement and entrainment of alewife, but no benefits were realized for rainbow smelt or gizzard shad. At the Roseton facility, the use of sound barriers provided little or no deterrence for any species (EPA 2008a). In its review, the EPA concluded that it may be possible to employ acoustic or light barrier systems in conjunction with other technologies to reduce impingement or entrainment, but further studies are likely necessary to evaluate the feasibility of various

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technology combinations. The 1999 DEIS from CHGEC et al. indicated an unknown cost associated with implementing behavioral deterrence systems.

4.2 Transmission Lines

The two transmission lines and right-of-ways (ROWs) built to connect IP2 and IP3 with the transmission system that existed before their construction are described in Section 2.1.7 and mapped on Figure 2-3 of this draft SEIS. The lines are each about 2000 ft (610 m) in length, and have ROW widths of approximately 150 ft (46 m). The transmission lines are located within the site except for a terminal, 100-ft (30.5-m) segment of each that crosses the facility boundary and Broadway (a public road) to connect to the Buchanan substation (Entergy 2007a).

Of the total of 4000 ft (1220 m) of transmission line, about 3500 ft (1070 m) traverses buildings, roads, parking lots, and other developed areas. The remaining 500 ft (150 m) of ROW is vegetated. In these segments, the growth of trees is prevented and a cover of mainly grasses and forbs is maintained.

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to the IP2 and IP3 transmission lines are listed in Table 4-5 of this draft SEIS. The applicant stated in its ER that it is not aware of any new and significant information associated with the renewal of the IP2 and IP3 operating licenses (Entergy 2007a). The NRC staff has not identified any new and significant information during its independent review of the Entergy ER, the NRC staff's site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there would be no impacts related to these issues beyond those discussed in the GEIS. For all of those issues, the NRC staff concluded in the GEIS that the impacts would be SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

Table 4-5. Category 1 Issues Applicable to the IP2 and IP3 Transmission Lines during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
TERRESTRIAL RESOURCES	
Power line right-of-way management (cutting and herbicide application)	4.5.6.1
Bird collisions with power lines	4.5.6.2
Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)	4.5.6.3
Floodplains and wetland on power line right-of-way	4.5.7
AIR QUALITY	
Air quality effects of transmission lines	4.5.2
LAND USE	
Onsite land use	4.5.3
Power line right-of-way	4.5.3

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ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections

A brief description of the GEIS conclusions, as codified in Table B-1, for each of these issues follows:

- Power line right-of-way management (cutting and herbicide application). Based on information in the GEIS, the Commission found the following:

  The impacts of right-of-way maintenance on wildlife are expected to be of small significance at all sites.

- Bird collisions with power lines. Based on information in the GEIS, the Commission found the following:

  Impacts are expected to be of small significance at all sites.

- Impacts of electromagnetic fields (EMFs) on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock). Based on information in the GEIS, the Commission found the following:

  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 wetlands on power line right-of-way. Based on information in the GEIS, the Commission found the following:

  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.

- Air quality effects of transmission lines. Based on the information in the GEIS, the Commission found the following:

  Production of ozone and oxides of nitrogen is insignificant and does not contribute measurably to ambient levels of these gases.

- Onsite land use. Based on the information in the GEIS, the Commission found the following:

  Projected on-site land use changes required during…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. Based on information in the GEIS, the Commission found the following:

  Ongoing use of power line rights-of-way would continue with no change in restrictions. The effects of these restrictions are of small significance.

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The NRC staff identified no new and significant information associated with these issues during the review. Therefore, the NRC staff expects that there would be no impacts during the renewal term beyond those discussed in the GEIS.

The NRC staff has identified one Category 2 issue and one uncategorized issue related to transmission lines. These issues are listed in Table 4-6 and are discussed in Sections 4.2.1 and 4.2.2 of this draft SEIS.

Table 4-6. Category 2 and Uncategorized Issues Applicable to the IP2 and IP3 Transmission Lines during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
HUMAN HEALTH			
Electromagnetic fields, acute effects (electric shock)	4.5.4.1	H	4.2.1
Electromagnetic fields, chronic effects	4.5.4.2	NA	4.2.2

4.2.1 Electromagnetic Fields—Acute Effects

Based on the GEIS, the Commission determined that electric shock resulting from direct access to energized conductors or from induced charges in metallic structures has not been found to be a problem at most operating plants and generally is 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 along the portions of the transmission lines that are within the scope of this draft SEIS.

In the GEIS, the NRC staff found that, without a review of the conformance of each nuclear plant transmission line to National Electrical Safety Code (NESC) (IEEE 1997) criteria, it was not possible to determine the significance of the electric shock potential. Evaluation of individual plant transmission lines is necessary because the issue of electric shock safety was not addressed in the licensing process for some plants. For other plants, land use in the vicinity of transmission lines may have changed, or power distribution companies may have chosen to upgrade line voltage. To comply with 10 CFR 51.53(c)(3)(ii)(H), the applicant must provide an assessment of the potential shock hazard if the 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.

As described in Section 2.1.7 of this draft SEIS, two 345-kilovolt (kV) transmission lines were built to distribute power from IP2 and IP3 to the electric grid. Also, two 138-kV lines that use the same transmission towers supply offsite (standby) power to IP2 and IP3. These lines are contained within the IP2 and IP3 site, except for where they cross Broadway (a public road) to connect to the Buchanan substation. Electric lines having voltages exceeding 98 kV of alternating current to ground must comply with the NESC provision on minimum vertical clearance, adopted in 1977, that limits the steady-state current from electrostatic effects to 5 milliamperes (mA) if the largest anticipated truck, vehicle, or equipment under the line were

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short circuited to ground. The New York Public Service Commission (NYPSC) requires a more restrictive induced current limit of 4.5 mA (Entergy 2007a).

Entergy indicates that at the time it acquired IP2 from the Consolidated Edison Company of New York, the transmission lines connecting IP2 and IP3 to the Buchanan substation were in compliance with the applicable NESC provisions for preventing electric shock from induced current. The lines were also in compliance with the NYPSC 4.5-mA criterion, as calculated using the methods described in the Electric Power Research Institute (EPRI) document "Transmission Line Reference Book" (Con Edison 2007). There have been no configuration or operation changes made to these lines since transfer of their ownership to Entergy (Entergy 2007a). Entergy indicates that it has maintenance procedures to ensure that the transmission lines continue to conform to ground clearance standards (Entergy 2008).

Entergy commissioned a study of the two 345-kV lines that connect IP2 and IP3 to the electric transmission system to demonstrate to the NRC staff that they meet the NESC and NYPSC requirements (Enercon 2008). The two 138-kV lines, which are at similar ground-crossing heights to the 345-kV lines, are also addressed by the study. The analysis was performed using the EPRI TL Workstation calculation software to determine the highest ground-level electric field strengths at the ROWs where they cross Broadway. Enercon employed procedures and calculations from the EPRI "Transmission Line Reference Book, 200kV and Above (Third Edition)", which Enercon indicates is the industry-accepted reference for transmission line design and field effects. Enercon notes that The EPRI parameters for a 55-ft- (17-m)-long tractor trailer were used, with the length increased to 65 ft (20 m) to represent the maximum allowed under New York size restrictions. The analysis revealed a maximum calculated induced current for the 345-kV lines of 1.3 mA, below the NYPSC 4.5-mA limit (Enercon 2008).

In the GEIS, the NRC staff found that electrical shock is of SMALL significance for transmission lines that are operated in adherence with the NESC criteria for limiting hazards. Based on a review of the available information, including that provided in the ER (Entergy 2007a), the NRC staff's environmental site audit, the scoping process, the NRC staff's evaluation of Entergy's 2008 study (Enercon 2008), and existing NESC requirements, the NRC staff concludes that the transmission lines associated with IP2 and IP3 meet NESC criteria for limiting hazards, and thus the potential impact from electric shock during the renewal term is SMALL.

The NRC staff identified measures that could further mitigate potential acute EMF impacts resulting from continued operation of the IP2 and IP3 transmission lines, including installing road signs at road crossings and increasing transmission line clearances. These mitigation measures could reduce human health impacts by minimizing public exposures to electric shock hazards. The staff did not identify any cost benefit studies applicable to the mitigation measures mentioned above.

4.2.2 Electromagnetic Fields—Chronic Effects

In the GEIS, the chronic effects of 60-hertz EMFs from power lines were not designated as Category 1 or 2, and a designation will not be made until scientific consensus is reached on the health implications of these fields.

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

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research through the U.S. Department of Energy (DOE). The 1999 report of the NIEHS and DOE Working Group (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 a 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 is not sufficient to cause the NRC to reach a conclusion with respect to the chronic effects of EMFs as detailed below (from 10 CFR Part 51, Subpart A, Appendix B, Table B-1):

> 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.

The NRC staff considers the GEIS finding of “uncertain” still appropriate and continues to follow developments on this issue.

4.3 Radiological Impacts of Normal Operations

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, applicable to IP2 and IP3 in regard to radiological impacts are listed in Table 4-7. Entergy stated in its ER that it was aware of one new issue associated with the renewal of the IP2 and IP3 operating licenses—potential ground water contamination and a new radioactive liquid effluent release pathway as a result of leakage from the plant. The NRC staff has discussed this issue and the various studies relating to it in Section 2.2.7 of this draft SEIS, and addresses the significance of this issue in Section 4.5. The NRC staff has not identified any new and significant information, beyond the new issue identified by the applicant in its ER, during its independent review of Entergy’s ER, the site audit, the scoping process, NRC inspection reports, or its evaluation of other available information.

As discussed in Sections 2.2.7 and 4.5 of this SEIS, the NRC staff concludes that the new issue is not significant, and thus does not challenge the finding in the GEIS. According to the GEIS, the impacts to human health are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

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Table 4-7. Category 1 Issues Applicable to Radiological Impacts of Normal Operations during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
HUMAN HEALTH	
Radiation exposures to public (license renewal term)	4.6.2
Occupational radiation exposures (license renewal term)	4.6.3

The NRC staff has not identified any new and significant information, beyond the new issue identified by the applicant in its ER concerning potential ground water contamination and a new radioactive effluent release pathway for leakage from the plant, during its independent review of Entergy's ER, the site audit, the scoping process, NRC inspection reports, or its evaluation of other available information. The NRC evaluated the detailed information provided by the applicant, State agencies, and NRC inspections on the new issue and concluded that the new issue is not significant and that the impacts are SMALL. Therefore, the NRC staff concludes that there would be no impact from radiation exposures to the public or to workers during the renewal term beyond those discussed in the GEIS.

The NRC staff concludes that the abnormal liquid releases discussed by Entergy in its ER, while new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20, "Standards for Protection against Radiation," and are not considered to have a significant impact on plant workers, the public, or the environment. Furthermore, the NRC staff acknowledges that the commitments made by Entergy—and identified in Section 2.2.7 of this SEIS—for long-term monitoring and remediation will help to minimize the potential impacts from contaminated ground water and help maintain radiological impacts within NRC radiation safety standards.

- Radiation exposures to public (license renewal term). Based on information in the GEIS, the Commission found the following:

  Radiation doses to the public will continue at current levels associated with normal operations.

- Occupational exposures to public (license renewal term). Based on information in the GEIS, the Commission found the following:

  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.

The NRC staff identified no information that was both new and significant on these issues during the review. Therefore, the NRC staff expects that there would be no impacts during the renewal term beyond those discussed in the GEIS.

There are no Category 2 issues related to radiological impacts of routine operations.

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4.4 Socioeconomic Impacts of Plant Operations during the License Renewal Term

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B–1, applicable to socioeconomic impacts during the renewal term are listed in Table 4-8 of this draft SEIS. As stated in the GEIS, the impacts associated with these Category 1 issues were determined to be SMALL, and plant-specific mitigation measures would not be sufficiently beneficial to be warranted.

Table 4-8. Category 1 Issues Applicable to Socioeconomics during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
SOCIOECONOMICS	
Public services: public safety, social services, and tourism and recreation	4.7.3; 4.7.3.3; 4.7.3.4; 4.7.3.6
Public services: education (license renewal term)	4.7.3.1
Aesthetic impacts (license renewal term)	4.7.6
Aesthetic impacts of transmission lines (license renewal term)	4.5.8

The NRC staff reviewed and evaluated the IP2 and IP3 ER, scoping comments, and other available information. The NRC staff also visited IP2 and IP3 in search of new and significant information that would change the conclusions presented in the GEIS. No new and significant information was identified during this review and evaluation. Therefore, the NRC staff concludes that there would be no impacts related to these Category 1 issues during the renewal term beyond those discussed in the GEIS.

The results of the review and brief statement of GEIS conclusions, as codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, for each of the socioeconomic Category 1 issues are provided below:

- Public services: public safety, social services, and tourism and recreation. Based on information in the GEIS, the Commission found the following:

  Impacts to public safety, social services, and tourism and recreation are expected to be of small significance at all sites.

- Public services: education (license renewal term). Based on information in the GEIS, the Commission found the following:

  Only impacts of small significance are expected.

- Aesthetic impacts (license renewal term). Based on information in the GEIS, the Commission found the following:

  No significant impacts are expected during the license renewal term.

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- Aesthetic impacts of transmission lines (license renewal term). Based on information in the GEIS, the Commission found the following:

  No significant impacts are expected during the license renewal term.

The NRC staff identified no new and significant information regarding these issues during the review. Therefore, the NRC staff expects that there would be no impacts during the renewal term beyond those discussed in the GEIS.

Table 4-9 lists the Category 2 socioeconomic issues, which require plant-specific analysis, and an environmental justice impact analysis, which was not addressed in the GEIS.

Table 4-9. Category 2 Issues Applicable to Socioeconomics and Environmental Justice during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
SOCIOECONOMICS			
Housing impacts	4.7.1	I	4.4.1
Public services: public utilities	4.7.3.5	I	4.4.2
Offsite land use (license renewal term)	4.7.4	I	4.4.3
Public services: transportation	4.7.3.2	J	4.4.4
Historic and archeological resources	4.7.7	K	4.4.5
Environmental justice	Not addressed[a]	Not addressed[a]	4.4.6

[a]Guidance related to environmental justice was not in place at the time the GEIS and the associated revision to 10 CFR Part 51 were prepared. Therefore, environmental justice must be addressed in plant-specific reviews.

4.4.1 Housing Impacts

Appendix C to the GEIS presents a population characterization method based on two factors, sparseness and proximity (see Section C.1.4). Sparseness measures population density within 20 miles (mi) (32 kilometers (km)) of the site, and proximity measures population density and city size within 50 mi (80 km). Each factor has categories of density and size (see Table C.1 of the GEIS). A matrix is used to rank the population category as low, medium, or high (see Figure C.1 of the GEIS).

In Chapter 2 of this draft SEIS, the NRC staff describes the local population around IP2 and IP3. As NRC staff indicated in Section 2.2.8.5, the 2000 U.S. Census noted that approximately 1,113,089 people lived within 20 mi (32 km) of IP2 and IP3, which equates to a population density of 886 persons per square mi (332 persons per square km). This density translates to the least sparse Category 4 (greater than or equal to 120 persons per square mi within 20 mi). Approximately 16,791,654 people live within 50 mi (80 km) of IP2 and IP3 (Entergy 2007a). This equates to a population density of 2138 persons per square mi (825 persons per square km). Applying the GEIS proximity measures, the IP2 and IP3 site is classified as proximity Category 4 (greater than or equal to 190 persons per square mi within 50 mi). Therefore, according to the sparseness and proximity matrix presented in the GEIS, IP2 and IP3 ranks of

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sparseness Category 4 and proximity Category 4 result in the conclusion that Indian Point is located in a high population area.

Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, states that impacts on housing availability are expected to be of small significance in high-density population areas where growth-control measures are not in effect. Since Indian Point is located in a high population area and Dutchess, Orange, Putnam, and Westchester Counties are not subject to growth-control measures that would limit housing development, any changes in IP2 and IP3 employment would have little noticeable effect on housing availability in these counties. Because Entergy has indicated in its ER that there would be no hiring of additional workers to support license renewal, nonoutage employment levels at IP2 and IP3 would remain relatively constant with no additional demand for permanent housing during the license renewal term (Entergy 2007a). In addition, the number of available housing units has kept pace with or exceeded the low growth in the area population. Based on this information, the NRC staff concludes that there would be no impact on permanent housing during the license renewal term beyond what is currently being experienced.

However, Entergy has indicated that it may replace IP2 and IP3 reactor vessel heads and control rod drive mechanisms (CRDMs) at some time in the future before or during the license renewal term, and the decision to proceed with this replacement activity would be made based on future inspection results (Entergy 2008b). Entergy estimates that this replacement activity at IP2 and IP3 would require an increase in the number of refueling outage workers for up to 60 days during two separate refueling outages, one for each unit, 12 months apart (Entergy 2008b). These additional workers would increase the demand for temporary (rental) housing in the immediate vicinity of IP2 and IP3. Even though it is not certain whether Entergy will replace the reactor vessel heads and CRDMs, the NRC staff has reviewed the potential environmental impacts of this replacement activity. These impacts are discussed in Chapter 3 of this draft SEIS.

4.4.2 Public Services—Public Utility Impacts

The GEIS indicates that impacts on public utilities are SMALL if the existing infrastructure could accommodate plant-related demand without a noticeable effect on the level of service. The GEIS indicates that 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. The GEIS indicates that LARGE impacts would result when new programs, upgraded or new facilities, or substantial additional staff are required because of plant-related demand.

In the absence of new and significant information to the contrary, the only impacts on public utilities that the NRC staff found in the GEIS could be significant during license renewal are impacts on public water supplies. The NRC staff's analysis of impacts on the public water and sewer systems considered both plant demand and plant-related population growth. In the GEIS, the NRC staff found that impacts from license renewal on public water supplies could range from SMALL to MODERATE, with the site-specific impact depending on factors that exist at each plant site.

As previously discussed (in Section 2.2.8.2) of this draft SEIS, potable water and process water is supplied to IP2 and IP3 by the Village of Buchanan water supply system (VBNY 2006). IP2

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and IP3 use approximately 2.3 million ft^3 (65,000 m^3) or 17.4 million gallons of potable water per month, and there is no indicated restriction on the amount of potable water that IP2 and IP3 can use. Further, Entergy (NRC 2007a) does not project an increase in plant demand.

Because Entergy staff has indicated that there would be no hiring of additional workers during the license renewal period (Entergy 2007a), overall employment levels at IP2 and IP3 would remain relatively unchanged with no additional demand for public water and sewer services. Public water systems in the region would remain adequate to meet the demands of residential and industrial customers in the area. Therefore, there would be no impact to public water and sewer services during the license renewal term beyond what is currently being experienced.

As discussed in Section 4.4.1 of this draft SEIS, Entergy might replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). The additional number of refueling outage workers needed for this replacement activity would cause short-term increases in the amount of public water and sewer services used in the immediate vicinity of IP2 and IP3. These impacts are discussed in Chapter 3 of this draft SEIS.

4.4.3 Offsite Land Use—License Renewal Period

Offsite land use during the license renewal term is a Category 2 issue (10 CFR Part 51, Subpart A, Appendix B, Table B-1). Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, notes that "significant changes in land use may be associated with population and tax revenue changes resulting from license renewal."

Section 4.7.4 of the GEIS defines the magnitude of land use changes as a result of plant operation during the license renewal term as follows:

> SMALL—Little new development and minimal changes to an area's land use pattern.
>
> MODERATE—Considerable new development and some changes to the land use pattern.
>
> LARGE—Large-scale new development and major changes in the land use pattern.

Tax revenue can affect land use because it enables local jurisdictions to provide the public services (e.g., transportation and utilities) necessary to support development. Section 4.7.4.1 of the GEIS states that the assessment of tax-driven land use impacts during the license renewal term should consider (1) the size of the plant's 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. If the plant's tax payments are projected to be small relative to the community's total revenue, 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. Section 4.7.2.1 of the GEIS states that if tax payments by the plant owner are less than 10 percent of the taxing jurisdiction's revenue, the significance level would be SMALL. 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. If the plant's tax payments are projected to be a dominant source of the

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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.

4.4.3.1 Population-Related Impacts

Since Entergy has indicated that it has no plans to add nonoutage employees during the license renewal period, there would be no noticeable population change to drive changes in land use conditions in the vicinity of IP2 and IP3 that is attributable to the plant. Therefore, there would be no population-related land use impacts during the license renewal term beyond those already being experienced.

As discussed in Section 4.4.1 of this SEIS, Entergy might replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). Because of the short amount of time needed for this replacement activity, the NRC staff finds that additional number of refueling outage workers would not cause any permanent population-related land use changes in the immediate vicinity of IP2 and IP3. These impacts are discussed in Chapter 3 of this draft SEIS.

4.4.3.2 Tax-Revenue-Related Impacts

As discussed in Chapter 2 of this draft SEIS, Entergy pays annual real estate taxes to the Town of Cortlandt, Hendrick Hudson Central School District, and the Village of Buchanan (see Table 2-18 in Chapter 2 for more detail). As reported in Chapter 2, tax payments to the Town of Cortlandt represented between 11 and 16 percent of the town's total annual tax revenues for the 3-year period from 2003 through 2005, and payments to the Hendrick Hudson Central School District represented approximately 30 to 38 percent of the school district's total revenues over the same time period. Entergy's tax payments to the Village of Buchanan make up a high percentage of the village's tax collection. For the period 2003 through 2005, tax payments to the Village of Buchanan represented 39 to 43 percent of the village's total revenues.

The NRC staff notes that since Entergy started making payments to local jurisdictions, population levels and land use conditions in the Town of Cortlandt, Village of Buchanan, and Westchester County have not changed significantly, which might indicate that these tax revenues have had little or no effect on land use activities within the county.

Entergy has indicated that it plans no license-renewal-related construction activities to support the continued operation of IP2 and IP3 during the license renewal period. Accordingly, the NRC staff expects that there would be no increase in the assessed value of IP2 and IP3 and that the annual payment-in-lieu-of-taxes and property taxes paid to the Town of Cortlandt, the Hendrick Hudson Central School District, and the Village of Buchanan would remain relatively unchanged throughout the license renewal period. Based on this information, there would be no tax-revenue-related land use impacts during the license renewal term beyond those currently being experienced.

As discussed in Section 4.4.1 of this draft SEIS, Entergy might replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). This replacement activity would not likely increase the assessed value of IP2 and IP3, and property tax payments would remain unchanged. These impacts are discussed in Chapter 3 of this draft SEIS.

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4.4.4 Public Services: Transportation Impacts during Operations

Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 states the following:

> Transportation impacts (level of service) of highway traffic generated...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.

All applicants are required by 10 CFR 51.53(c)(3)(ii)(J) to assess the impacts of highway traffic generated by the proposed project on the level of service of local highways during the term of the renewed license.

Since Entergy has no plans to add nonoutage employees during the license renewal period, there would be no noticeable change in traffic volume and levels of service on roadways in the vicinity of IP2 and IP3. Therefore, there would be no transportation impacts during the license renewal term beyond those already being experienced.

As discussed in Section 4.4.1 of this draft SEIS, Entergy might replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). The additional number of outage workers and truck material deliveries needed to support this replacement activity could cause short-term transportation impacts on access roads in the immediate vicinity of IP2 and IP3. These impacts are discussed in Chapter 3 of this draft SEIS.

4.4.5 Historic and Archeological Resources

The National Historic Preservation Act (NHPA), as amended, requires Federal agencies to consider the effects of their undertakings on historic properties. Historic properties are defined as resources that are eligible for listing on the National Register of Historic Places. The criteria for eligibility are listed in 36 CFR 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) embodies distinctive characteristics of type, period, or construction, and (4) yielded or is likely to yield important information (ACHP 2008). The historic preservation review process mandated by Section 106 of the NHPA is outlined in regulations issued by the Advisory Council on Historic Preservation in 36 CFR Part 800, "Protection of Historic Properties." The issuance of a renewed operating license for a nuclear power plant is a Federal action that could possibly affect either known or currently undiscovered historic properties located on or near the plant site and its associated transmission lines. In accordance with the provisions of the NHPA, the NRC is required to make a reasonable effort to identify historic properties in the areas of potential effect. If no historic properties are present or affected, the NRC is required to notify the State Historic Preservation Office before proceeding. If it is determined that historic properties are present, the NRC is required to assess and resolve possible adverse effects of the undertaking.

4.4.5.1 Site-Specific Cultural Resources Information

A review of the New York State Historic Preservation Office (NYSHPO) files shows that there are no previously recorded archeological or above-ground historic architectural resources identified on the IP2 and IP3 property. As noted in Section 2.2.9.1 of this draft SEIS, a

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Phase 1A survey (literature review and background research) of the plant property was conducted in 2006; however, no systematic pedestrian or subsurface archeological surveys have been conducted at the IP2 and IP3 site. Background research revealed a total of 76 resources listed on the National Register of Historic Places within a 5-mile radius of IP2 and IP3; however, none are located within the boundaries of the property.

There is potential for archeological resources to be present on some portions of the IP2 and IP3 property. As noted in Section 2.2.9.2 of this draft SEIS, because of disturbances associated with site preparation and construction, the power block area at IP2 and IP3 has little or no potential for archeological resources. There is potential for archeological resources to be present in the wooded area northeast of the power block area. A portion of the property south and east of the power block area, which contains a variety of ancillary plant facilities, has been disturbed by construction activities over the course of the plant's history. It is possible, however, that portions of that area not disturbed by construction activities may contain intact subsurface archeological deposits. In addition, the IP1 reactor was one of three "demonstration plants" that began operation in the early 1960s. It is representative of the earliest era of commercial reactors to operate in the United States. To date, no formal significance or eligibility evaluation has been conducted for IP1; however, the plant could become eligible for inclusion on the National Register of Historic Places. As mandated by Section 106 of the NHPA, an evaluation would be conducted if it was determined that a project could affect IP1.

4.4.5.2 Conclusions

Entergy has proposed no specific new facilities, service roads, or transmission lines for the IP2 and IP3 site *associated with continued operation and* refurbishment. However, Entergy indicated that it may replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal period. This activity would involve ground-disturbing activities associated with the construction of a storage building for the existing reactor vessel heads and CRDMs. Ground-disturbing activities would be reviewed in accordance with Entergy nuclear fleet procedures, which are designed to ensure that investigations and consultations are conducted as needed, and that existing or potentially existing cultural resources are adequately protected by Entergy such that the applicant can meet State and Federal expectations (Enercon 2007).

Therefore, the potential for impacts from continued operation of IP2 and IP3 on historic or archeological resources eligible for the National Register is SMALL. However, as noted in the NRC staff walkover survey discussed in Chapter 2 of this draft SEIS, there is the potential for prehistoric and historic archeological resources to be present on the northeastern portion of the site. Even though this area was previously disturbed by surface mining in the 19th century, the potential for intact prehistoric/historic and archeological resources remains. In addition, Section 106 of NHPA requires that lands not previously surveyed in the vicinity of IP2 and IP3 would require investigation by a professional archeologist in consultation with the NYSHPO before any ground-disturbing activities. To mitigate any potential adverse impacts to historic and archeological resources from continued plant operations in these areas, field surveys (archeological investigations) and consultation under the NHPA should be conducted before any ground-disturbing activities. Entergy procedures should be followed to mitigate any potential adverse impacts to historic and archeological resources.

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4.4.6 Environmental Justice

Under Executive Order 12898, "Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations" (Volume 59, page 7629 of the *Federal Register* (59 FR 7629)), Federal agencies are responsible for identifying and addressing potential disproportionately high and adverse human health and environmental impacts on minority and low-income populations. In 2004, the Commission issued its "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 E.O. 12898, and strives to meet those goals as part of its NEPA review process."

The Council of Environmental Quality (CEQ) provides the following information in its publication entitled, "Environmental Justice: Guidance under the National Environmental Policy Act" (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 defined by NEPA Act) 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 defined 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 defined 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).

The 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 IP2 and IP3 during the renewal term. In assessing the impacts, the following CEQ (1997) definitions of minority individuals and populations and low-income population were used:

(1) **Minority individuals**. Individuals who identify themselves as members of the following population groups: Hispanic or Latino, American Indian or Alaska 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, Hispanic and Asian.

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(2) **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.

(3) **Low-income populations**. Low-income populations in an affected area are identified with the annual statistical poverty thresholds from the Census Bureau's Current Population Reports, Series PB60, on Income and Poverty.

Minority Population in 2000

According to 2000 census data, 48.7 percent of the population (approximately 16,805,000 individuals) residing with a 50-mi (80-km) radius of IP2 and IP3 identified themselves as minority individuals. The largest minority group was Black or African American (3,480,000 persons or 20.7 percent), followed by Hispanic or Latino of any race (3,439,000 or about 20.5 percent) (USCB 2003—LandView 6). About 36 percent of the Westchester County population were minorities, with Hispanic or Latino the largest minority group (15.6 percent) followed by Black or African American (13.6 percent) (USCB 2008).

Census block groups with minority populations exceeding 50 percent were considered minority block groups. Based on 2000 census data, Figure 4-5 of this draft SEIS shows minority block groups within a 50-mi (80-km) radius of IP2 and IP3 in which more than 50 percent of the block group population is minority.

Low-Income Population in 2000

According to 2000 census data, approximately 484,000 families (approximately 11.7 percent) residing within a 50-mi (80-km) radius of the IP2 and IP3 were identified as living below the Federal poverty threshold in 1999 (USCB 2003—LandView 6). The 1999 Federal poverty threshold was $17,029 for a family of four.

According to census data, the median household income for New York in 2004 was $45,343, while 14.5 percent of the State's population was determined to be living below the Federal poverty threshold. Westchester County had a much higher median household income ($63,924) and a lower percentage (8.9 percent) of individuals living below the poverty level when compared to the State. Dutchess, Orange, and Putnam Counties also had much higher median household incomes in 2004 ($56,971, $54,771, and $75,514, respectively) and lower percentages (7.7 percent, 10.2 percent, and 4.5 percent, respectively) of individuals living below the poverty level when compared to the State (USCB 2008).

Census block groups were considered low-income block groups if the percentage of the population living below the Federal poverty threshold exceeded the State percentage of 14.5 percent. Based on 2000 census data, Figure 4-6 of this draft SEIS shows low-income block groups within a 50-mi (80-km) radius of IP2 and IP3.

Analysis of Impacts

Consistent with the impact analysis for the public and occupational health and safety, the affected populations are defined as minority and low-income populations residing within a 50-mi radius of the IP2 and IP3. Based on the analysis of environmental health and safety impacts presented in this draft SEIS for other resource areas (contained in Chapters 2 and 4 of this SEIS), there would be no disproportionately high and adverse impacts to minority and low-

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income populations from continued operation of IP2 and IP3 during the license renewal period.

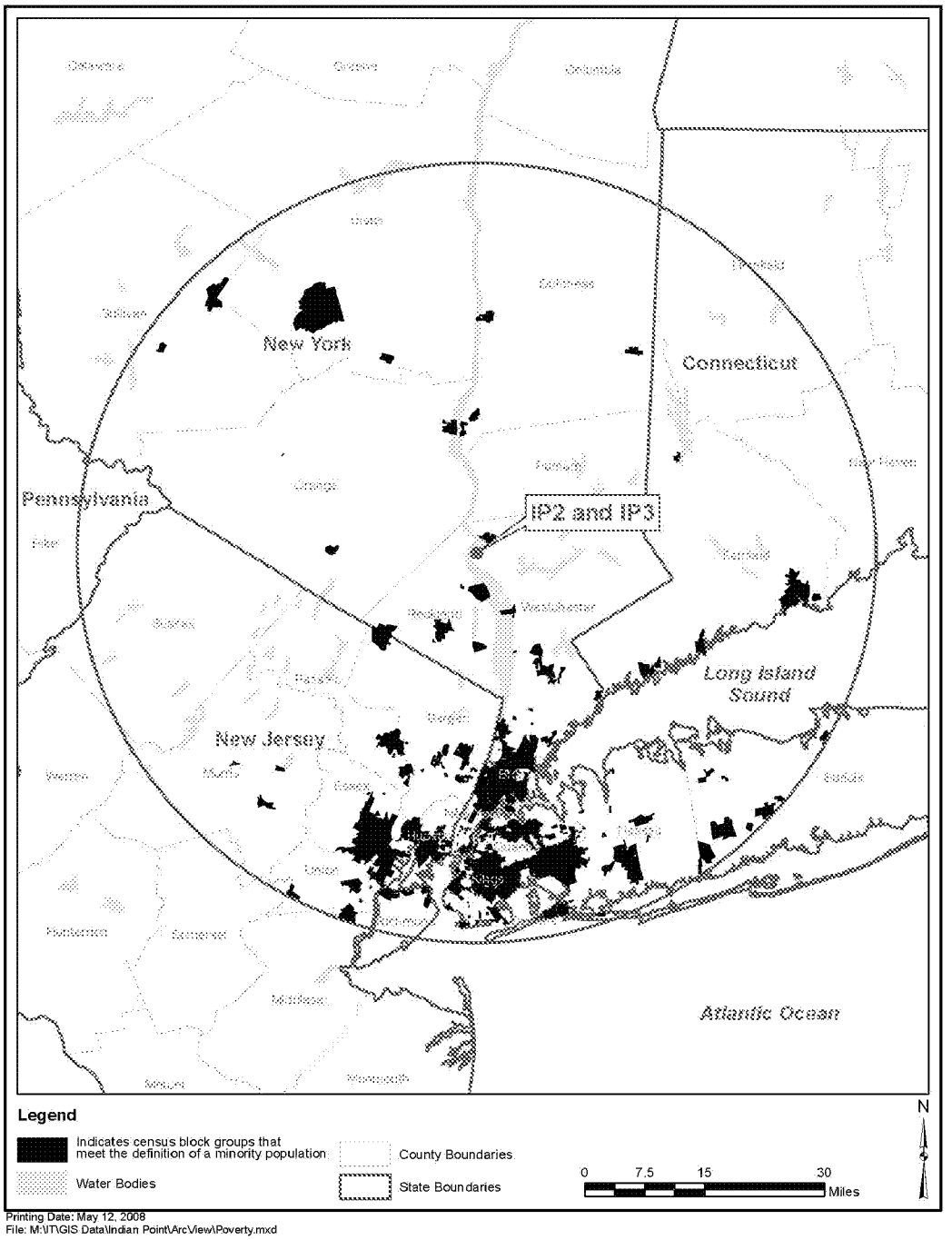

Figure 4-5. Minority block groups in 2000 within a 50-mi radius of IP2 and IP3 (USCB 2008)

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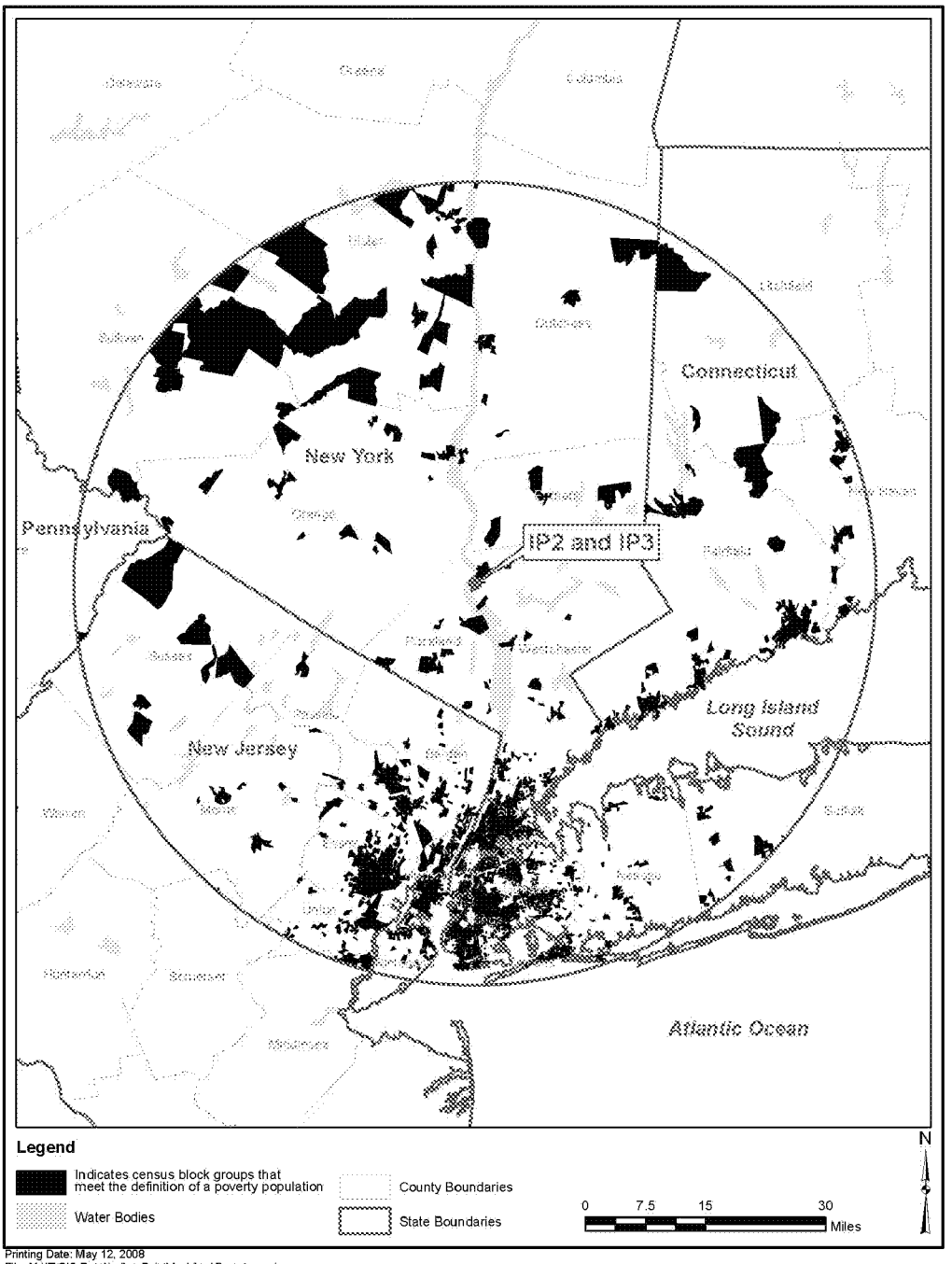

Figure 4-6. Low-income block groups in 2000 within a 50-mi radius of IP2 and IP3 (USCB 2008)

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Environmental Impacts of Operation

As discussed in Section 4.4.1, Entergy might replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal term (Entergy 2008b). Entergy estimates that this would require an increase in the number of refueling outage workers for up to 60 days during two separate refueling outages, one for each unit, 12 months apart (Entergy 2008b). This replacement activity would have little noticeable affect on minority and/or low-income populations in the region. These impacts are discussed in Chapter 3 of this draft SEIS.

The NRC also analyzed the risk of radiological exposure through the consumption patterns of special pathway receptors, including subsistence consumption of fish, native vegetation, surface waters, sediments, and local produce; absorption of contaminants in sediments through the skin; and inhalation of plant materials. The special pathway receptors analysis is important to the environmental justice analysis because consumption patterns may reflect the traditional or cultural practices of minority and low-income populations in the area.

Subsistence Consumption of Fish and Wildlife

Section 4-4 of Executive Order 12898 (1994) directs Federal agencies, whenever practical and appropriate, to collect and analyze information on the consumption patterns of populations who rely principally on fish and/or wildlife for subsistence and to communicate the risks of these consumption patterns to the public. In this draft SEIS, the NRC staff considered whether there were any means for minority or low-income populations to be disproportionately affected by examining impacts to American Indian, Hispanic, and other traditional lifestyle special pathway receptors. Special pathways that took into account the levels of contaminants in native vegetation, crops, soils and sediments, surface water, fish, and game animals on or near the IP2 and IP3 site were considered.

Entergy has a comprehensive Radiological Environmental Monitoring Program (REMP) at IP2 and IP3 to assess the impact of site operations on the environment. Samples are collected from the aquatic and terrestrial pathways in the vicinity of IP2 and IP3. The aquatic pathways include fish, Hudson River water, ground water, aquatic vegetation, sediment, and shoreline soil. The terrestrial pathways include airborne particulates, broad leaf vegetation, and direct radiation. During 2006, Entergy or its contractors performed 1342 analyses on collected samples of environmental media as part of the required REMP which showed no significant or measurable radiological impact from IP2 and IP3 operations (ENN 2007).

The NRC staff presents a summary of results from the IP2 and IP3 REMP program in Section 2.2.7 of this draft SEIS. The results of the 2006 REMP (the most recent available) demonstrate that the routine operation at the IP2 and IP3 site has had no significant or measurable radiological impact on the environment. No elevated radiation levels were detected in the offsite environment as a result of plant operations and the storage of radioactive waste. The results of the REMP continue to demonstrate that the operation of IP2 and IP3 did not result in a significant measurable dose to a member of the general population or adversely impact the environment as a result of radiological effluents. The REMP continues to demonstrate that the dose to a member of the public from the operation of IP2 and IP3 remains significantly below the Federally required dose limits specified in 10 CFR Part 20 and 40 CFR Part 190, “Environmental Radiation Protection Standards for Nuclear Power Operations.”

The NRC staff’s review of recent REMP monitoring results shows that concentrations of contaminants in native leafy vegetation, soils and sediments, surface water, and fish in areas surrounding IP2 and IP3 have been quite low (at or near the threshold of detection) and seldom

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above background levels. Consequently, the NRC staff concludes that no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of fish and wildlife.

4.5 Ground Water Use and Quality

No Category 1 or Category 2 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, are potentially applicable to IP2 and IP3 ground water use and quality during the renewal term. The applicant stated in its ER that IP2 and IP3 do not use any ground water, though onsite monitoring wells exist for the purpose of monitoring ground water conditions.

In the IP2 and IP3 ER, Entergy identified leakage from onsite spent fuel pools as potentially new and significant information (Entergy 2007a). The NRC staff has reviewed Entergy's analysis of the leakage and has conducted an extensive onsite inspection of leakage to ground water, as identified in Section 2.2.7 of this draft SEIS. Based on the NRC staff's review of Entergy's analysis, the NRC staff's adoption of the NRC inspection report findings in this SEIS, and Entergy's subsequent statements (all discussed in Section 2.2.7), the NRC staff concludes that the abnormal liquid releases discussed by Entergy in its ER, while new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20 and are not considered to have a significant impact on plant workers, the public, or the environment (i.e., while the information related to spent fuel pool leakage is new, it is not significant).

4.6 Threatened or Endangered Species

Potential impacts to 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 4-10.

Table 4-10. Category 2 Issues Applicable to Threatened or Endangered Species during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(c)(3)(ii) Subparagraph	Draft SEIS Section
THREATENED OR ENDANGERED SPECIES (FOR ALL PLANTS)			
Threatened or Endangered Species	4.1	E	4.6

This issue requires consultation under Section 7 of the Endangered Species Act of 1973 (ESA 1973) 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 facility during the license renewal term. The presence of threatened or endangered species in the vicinity of the IP2 and IP3 site is discussed in Sections 2.2.5.5 and 2.2.6.2 of this draft SEIS. In 2007, the NRC staff contacted NMFS and the U.S. Fish and Wildlife Service (FWS) to request information on the occurrence of threatened or endangered species in the vicinity of the site and the potential for impacts on those species from license renewal. NMFS identified in its response two Federally protected sturgeon species under its jurisdiction as having the potential to be affected by the proposed action (NMFS 2007a). FWS provided a link to the Web site of its New York Field Office, where lists of species occurrences were available by county (FWS

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2007). Three terrestrial species with a Federal listing status were identified as potentially occurring at or near the site—the Indiana bat (*Myotis sodalis*), bog turtle (*Clemmys muhlenbergii*), and New England cottontail (*Sylvilagus transitionalis*).

Because the NRC recognizes that there is the potential that the continued operation of IP2 and IP3 could adversely affect the Federally listed species shortnose sturgeon (*Acipenser brevirostrum*), the NRC staff has prepared a biological assessment (BA) for NMFS that documents its review. The BA is provided in Appendix E to this draft SEIS. During informal consultation regarding the potential for effects on terrestrial threatened or endangered species, FWS determined that a BA was not needed because there was no likelihood of adverse effects on potentially occurring species under its jurisdiction (NRC 2008).

4.6.1 Aquatic Threatened or Endangered Species

Pursuant to Section 7 of the Endangered Species Act of 1973 (ESA 1973), the NRC staff requested in a letter dated August 16, 2007 (NRC 2007a), that NMFS provide information on Federally listed endangered or threatened species, as well as proposed candidate species. In its response on October 4, 2007 (NMFS 2007b), NMFS expressed concern that the continued operation of IP2 and IP3 could have an adverse impact on the shortnose sturgeon, an endangered species that occurs in the Hudson River. NMFS also noted that the Atlantic sturgeon (*A. oxyrinchus*) also occurs in the river and is currently a candidate for listing as threatened or endangered. The NRC staff also reviewed the list of threatened and endangered fish species available at the NYSDEC Web site (NYSDEC 2008a) and determined that the only listed species occurring in the Hudson River near the IP2 and IP3 facility was the shortnose sturgeon. Based on this information, the NRC staff determined that an analysis of impacts was required only for the shortnose sturgeon. The NRC staff has, however, included an assessment of impact for the Atlantic sturgeon in this section, given its current status as a candidate for listing.

As described in Section 2.2.5.5 of this draft SEIS, the shortnose sturgeon is amphidromous, with a range extending from St. Johns River, Florida, to St. John River, Canada. Unlike anadromous species, shortnose sturgeons spend the majority of their lives in freshwater and move to salt water periodically, independent of spawning periods (Collette and Klein-MacPhee 2002). The shortnose sturgeon was listed on March 11, 1967, as endangered under the Endangered Species Act of 1973, as amended. In 1998, a recovery plan for the shortnose sturgeon was finalized by NMFS (NMFS 1998).

Shortnose sturgeon are found in the lower Hudson River and are dispersed throughout the river-estuary from late spring to early fall, congregating to winter near Sturgeon Point (RKM 139; RM 86). The population of shortnose sturgeon in the Hudson River has increased 400 percent since the 1970s, according to Cornell University researchers (Bain et al. 2007). Woodland and Secor (2007) estimate a fourfold increase in sturgeon abundance over the past 3 decades, but report that the population growth slowed in the late 1990s as evidenced by the nearly constant recruitment pattern at depressed levels relative to the classes in 1986–1992. Although the Hudson River appears to support the largest population of shortnose sturgeon in the region, Bain et al. (2007) report that other populations along the Atlantic coast are also increasing and some appear to be nearing safe levels, suggesting that the overall population could recover if full protection and management continue.

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As described in Section 2.2.5.5 of this draft SEIS, the Atlantic sturgeon is an anadromous species with a range extending from St. Johns River, Florida, to Labrador, Canada. This species is long lived, matures slowly, and can reach 60 years of age (ASMFC 2007; Gilbert 1989). In 1996, the State of New York placed a moratorium on harvesting Atlantic sturgeon when it became apparent that the Hudson River stock was overfished. Unfortunately, the American shad gill net fishery continues to take subadult sturgeon as bycatch (e.g., the unintentional collection of some species during the harvest or others). The Status Review Team for Atlantic Sturgeon concluded in 2007 that the Hudson River subpopulation has a moderate risk (less than 50 percent) of becoming endangered in the next 20 years because of the threat of commercial bycatch. However, the New York Bight distinct population segment, which includes the Hudson River subpopulation, was determined to have a greater than 50-percent chance of becoming endangered in the foreseeable future. Despite this, the Hudson River supports the largest subpopulation of spawning adults and juveniles, and the abundance appears to be stable or even increasing (ASSRT 2007). Recent work by Sweka et al. (2007) suggests that a substantial population of juvenile Atlantic sturgeon is present in Haverstraw Bay, and that this area should be the focus of future monitoring studies to obtain the greatest statistical power for assessing population trends.

To determine the potential adverse impacts of the IP2 and IP3 cooling system on these species, the NRC staff evaluated the potential effects of entrainment, impingement, and thermal discharges for all RIS, including both sturgeon species, in Sections 4.1.1, 4.1.2, and 4.1.3 of this draft SEIS. Based on an evaluation of entrainment data provided by the applicant, there is no evidence that the eggs or larvae of either species are commonly entrained at IP2 or IP3. The potential impacts of thermal discharges on shortnose and Atlantic sturgeon cannot be determined at this time because additional studies are required to quantify the extent and magnitude of the thermal plume, as discussed in Section 4.1.4 of this draft SEIS.

Impingement data provided by the applicant (Entergy 2007b) suggest that both species of sturgeon have been impinged at IP2 and IP3, with impingement of Atlantic sturgeon accounting for the largest losses (Table 4-11). Impingement data for the endangered shortnose sturgeon show that from 1975 to 1990, 317 fish were impinged at IP2 and 407 fish were impinged at IP3. Impingement of this species was greatest in 1984 and 1988, and no impinged fish were observed at either unit in 1981, 1982, 1983, 1985, and 1986 (Table 4-11). Impingement of Atlantic sturgeon was much greater than that observed for shortnose sturgeon, with 2667 fish impinged at IP2 and 1268 fish impinged at IP3 between 1975 and 1988. The only year when impingement of Atlantic sturgeon at both units was not observed (Table 4-11) was 1988. Because recent data are not available, it is not possible to determine whether the current impingement losses are similar to the past observations.

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Table 4-11. Impingement Data for Shortnose and Atlantic Sturgeon at IP2 and IP3, 1975–1990 (data from Entergy 2007b)

Study Year	IP2		IP2 Total	IP3		IP3 Total	Grand Total
	Shortnose Sturgeon	Atlantic Sturgeon		Shortnose Sturgeon	Atlantic Sturgeon		
1975	3	302	305	-[a]	-	-	305
1976	2	17	19	-	14	14	33
1977	11	105	116	2	252	254	370
1978	5	38	43	5	31	36	79
1979	4	75	79	3	61	64	143
1980	-	24	24	2	17	18	42
1981	-	221	221	-	73	73	294
1982	-	217	217	-	127	127	344
1983	-	149	149	-	-	-	149
1984	176	363	539	154	179	333	872
1985	-	460	460	-	300	300	760
1986	-	696	696	-	126	126	822
1987	116	-	116	55	88	143	259
1988	-	-	-	186	-	186	186
1989	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-
Grand Total	317	2667	2984	407	1268	1674	4658

(a) – = not indicated in sample

The NRC staff reviewed information from the site audit, Entergy's ER for the IP2 and IP3 site, other reports, and information from NMFS. Because of the uncertainty of the current impingement losses of both species of sturgeon and because insufficient data exist to use the WOE approach used earlier in Chapter 4 to address impacts to RIS, operation of IP2 and IP3 has the potential to adversely affect the Atlantic and shortnose sturgeons during the license renewal term. Therefore, the NRC staff concludes that the impacts of an additional 20 years (beyond the current term) of operation and maintenance of the site, including associated transmission line ROWs, on aquatic species that are Federally listed as threatened or endangered could be SMALL to LARGE. However, if monitoring were to be reinstated at IP2 and IP3, the range of impact levels from continued operation could possibly be refined.

The NRC staff has included a biological assessment of the impacts of license renewal on the shortnose sturgeon in Appendix E to this draft SEIS for NMFS to review. Should NMFS determine that there is a potential that the continued operation of IP2 and IP3 will adversely impact the shortnose sturgeon, NMFS will issue a biological opinion. Included in the biological opinion would be any reasonable and prudent measures that the applicant could undertake, as well as the terms and conditions for the applicant to comply with the formal Section 7 consultation. Possible mitigation measures could range from monitoring to determine the number of shortnose sturgeon impinged at IP2 and IP3 to changes in the cooling water intake

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system, as described in Section 4.1.5 of this draft SEIS. Additionally, as described in Chapter 8, the installation of cooling towers could reduce impingement, entrainment, and thermal impacts for all aquatic resources, including those that are Federally listed.

4.6.2 Terrestrial Threatened or Endangered Species

There are two Federally listed terrestrial species that have the potential to occur at or near the IP2 and IP3 site and its associated transmission line ROWs, the endangered Indiana bat (M. *sodalis*) and the threatened bog turtle (C. *muhlenbergii*). A candidate species, the New England cottontail (S. *transitionalis*), also may occur in the vicinity. The characteristics, habitat requirements, and likelihood of occurrence of each of these species are discussed in Section 2.2.6.2 of this draft SEIS.

Although Westchester County is within the potential range of the Indiana bat in New York, winter hibernacula and summer maternity colonies and bachelor colonies are not known to be present in the county or the vicinity of the site (NYNHP 2008a). The NRC staff notes that it is possible that the 70-acre (ac) (28-hectare (ha)) forest at the north end of the site could provide summer habitat for the Indiana bat because of the presence of suitable foraging habitat and possible roosting trees in the forest and the presence of large hibernacula within migration distance of the site. The ER indicated that no expansion of existing facilities or disturbance of forest or other land on the site would occur during the renewal period. Thus, even if Indiana bats currently utilize habitat on the site, it is not likely that they would be adversely affected by ongoing operations and maintenance activities during the renewal period.

In Section 2.2.6.2, the NRC staff noted that the IP2 and IP3 site area does not have suitable habitat for the bog turtle, and that bog turtles have not been observed in the region of Westchester County near the IP2 and IP3 site (NYSDEC 2008b). The NRC staff acknowledged that wetlands nearest the site had not, however, been evaluated for the presence of the bog turtle. Given the available information, the NRC staff concludes that the bog turtle is not likely to occur on or in the immediate vicinity of the site. The known locations of the New England cottontail in Westchester County are in the central and northeastern areas of the county (NYNHP 2008b), not in the northwestern area where the site is located. The forests on the site consist mainly of mature hardwoods and do not contain early successional habitats, such as thickets, that are required by the New England cottontail, so the NRC staff does not expect the species to occur on or in the immediate vicinity of the site.

The NRC staff reviewed information from the site audit, Entergy's ER for the IP2 and IP3 site, other reports, and information from FWS. Operation of IP2 and IP3 is not expected to adversely affect any threatened or endangered terrestrial species during the license renewal term. Therefore, the NRC staff concludes that the impacts of an additional 20 years of operation and maintenance of the site, including associated transmission line ROWs, on terrestrial species that are Federally listed as threatened or endangered would be SMALL. Because no listed species are known to be present in the area of the IP2 and IP3 site, there are no recommended mitigation measures, unless the applicant becomes aware of the presence of a listed species, in which case appropriate protective action should be taken, and the NRC and FWS should be notified. Informal consultation with FWS indicated that formal consultation and a BA are not required for terrestrial threatened or endangered species.

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4.7 Evaluation of New and Potentially Significant Information on Impacts of Operations during the Renewal Term

The NRC staff has conducted its own independent review of environmental issues through staff research, consultation with State and Federal agencies, and comments delivered to the NRC by the public during the environmental scoping period to identify potentially new and significant information about environmental issues listed in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, related to operation of IP2 and IP3 during the renewal term. Processes for identification and evaluation of new information are described in Section 1.2.2 of this draft SEIS.

As discussed in Section 2.2.7 of this draft SEIS and synopsized in Section 4.5 of this chapter, Entergy identified leakage from onsite spent fuel pools as potentially new information (Entergy 2007a). The NRC staff has reviewed Entergy's analysis of the leakage and has conducted an extensive onsite inspection of leakage to ground water, as identified in Section 2.2.7 of this draft SEIS. Based on the NRC staff's review of Entergy's ground water analyses, the NRC ground water inspection report, and Entergy's subsequent statements (all discussed in Section 2.2.7 of this draft SEIS), the NRC staff concludes that the abnormal liquid releases discussed by Entergy in its ER, while constituting new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20 and are not considered to have a significant impact on plant workers, the public, or the environment (i.e., while the information related to spent fuel pool leakage is new, it is not significant).

The NRC staff did not identify any other information that was both new and significant. As such, the NRC staff adopts the GEIS findings for Category I issues applicable to Indian Point, as described in the previous sections of this chapter.

4.8 Cumulative Impacts

The NRC staff considered potential cumulative impacts on the environment resulting from past, present, and reasonably foreseeable future actions. The geographical area over which past, present, and future actions are assessed is dependent on the affected resource.

The impacts of the proposed action, license renewal, as described in previous sections of Chapter 4 of this draft SEIS, are combined with other past, present, and reasonably foreseeable future actions in the potentially affected area regardless of which agency (Federal or non-Federal) or entity is undertaking the actions. The combined impacts are defined as "cumulative" in 40 CFR 1508.7, "Cumulative Impact," and include individually minor but collectively significant actions taking place over a period of time (CEQ 1997). It is possible that an impact that may be SMALL by itself could result in a MODERATE or LARGE impact when considered in combination with the impacts of other actions on the affected resource. Likewise, if a resource is regionally declining or imperiled, even a SMALL direct or indirect impact could be important if it contributes to or accelerates the overall resource decline.

The NRC staff has identified the principal past, present, and reasonably foreseeable future actions potentially impacting the environment affected by IP2 and IP3. The potential cumulative impacts of these actions are discussed below.

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4.8.1 Cumulative Impacts on Aquatic Resources

The purpose of this section is to address past, present, and future actions that have created or could result in cumulative adverse impacts to the aquatic resources of the lower Hudson River. In Section 2.2.5.2 of this SEIS, the NRC staff discussed a wide variety of historical events that have affected the Hudson River and its resources. The NRC staff notes that these historical events are contributors to the cumulative effects on the Hudson River. In addition to the past events in Section 2.2.5.2, the NRC staff has identified a variety of current and likely future stressors that may also contribute to cumulative impacts. These stressors, included in the follow list, is consistent with those identified by the Pew Oceans Commission (2003).

- the continued operation of the IP2 and IP3 once-through cooling system (addressed in Section 4.1 of this Chapter)
- continued withdrawal of water to support fossil fuel electrical generation or water for human use
- the presence of invasive or nuisance species
- fishing pressure
- habitat loss
- changes to water and sediment quality
- climate change

Each of these potential stressors may influence the structure and function of freshwater, estuarine, and marine food webs and result in observable changes to the aquatic resources in the lower Hudson River estuary. Examples of measurable changes to aquatic resources could include the following:

- reductions or increases in RIS populations or changes in their distribution
- changes in predator-prey relationships or noticeable alterations to food webs, including the permanent loss of species
- changes in contaminant body-burdens in fish and shellfish that result in the imposition or lifting of consumption advisories
- introduction of exotic or nuisance species and increases or decreases in populations of existing invasive species

What follows is a brief discussion of how the stressors listed above might have cumulative impacts on aquatic resources of the lower Hudson River estuary. An expanded discussion of cumulative impacts is presented in Appendix H to this draft SEIS. Because in most cases it is not possible to quantitatively determine the impact of each stressor, or a collection of stressors, on the aquatic resources of the lower Hudson River, the following is a general discussion of cumulative impacts.

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Continued Operation of the IP2 and IP3 Once-Through Cooling System

Based on the assessment presented in Sections 4.1.3 and 4.1.4 of this draft SEIS, the NRC staff concludes that the operation of IP2 and IP3 has the potential to adversely affect a variety of RIS species that currently exist in the Hudson River between Troy Dam and the Battery. Based on the staff's analysis of entrainment and impingement impacts, effects to RIS range from SMALL to LARGE, depending on the species affected. It is also possible that the operation of IP2 and IP3 could be affecting the endangered shortnose sturgeon. If the IP2 and IP3 once-through cooling system continues to operate as it has for the past 3 decades, the NRC staff finds that it will continue to contribute to cumulative effects.

Continued Water Withdrawals

As described in Section 2.2.5 of this draft SEIS, water is withdrawn from the Hudson River to support fossil fuel electrical generation and to provide a source of drinking water. Although some fossil fuel electrical generating stations that use natural gas or oil operate only intermittently, coal-fired electrical generation stations that employ once-through cooling systems are expected to continue to operate in the future. Likewise, water withdrawals in the freshwater portions of the Hudson River will continue to occur and increase in the future. Because the NRC staff concludes that water withdrawals from the Hudson River to support human needs will continue and will likely increase during the relicensing term, this stressor will continue to contribute to the cumulative effects in the river.

Invasive and Nuisance Species

As discussed in Section 2.2.5 of this draft SEIS, the presence of invasive or nuisance species in the Hudson River estuary has been documented for over 200 years. While the presence of new or exotic species can benefit some existing species, introductions of new species often have a negative impact on their new environment. A classic example of the latter is the appearance of the zebra mussel in the freshwater portion of the Hudson River in 1991. Since 1992, zebra mussels have been a dominant species in the freshwater tidal portion of the Hudson River and constitute more than half of heterotrophic biomass. Strayer (2007) estimated that the current population is capable of filtering a volume of water equal to all of the water in the estuary every 1 to 4 days during the summer.

Some evidence suggests that the presence of zebra mussels can affect the species composition and abundance of some Hudson River RIS. Strayer et al. (2004) hypothesized that the abundance or growth rates of American shad, blueback herring, alewife, gizzard shad, white perch, and striped bass would decline following the zebra mussel invasion or that their distributions within the river would shift downriver away from the zone of greatest zebra mussel impacts. The authors found that significant decreases in early lifestages of the estimated riverwide abundance of several species of fish coincided with the zebra mussel invasion, including American shad and white perch. Barnthouse et al. (2008) also concluded that zebra mussels may have contributed to declines in white perch, but rejected the hypothesis that zebra mussels were affecting American shad. Independent analyses by the staff suggested that the presence of zebra mussels resulted in a MODERATE to LARGE potential for adverse impacts to the American shad, blueback herring, spottail shiner, and white perch (see Appendices H and I to this draft SEIS). The presence of invasive or nuisance species in the lower Hudson River will continue to be a concern, as it is in other locations throughout the world, and the presence of these species will continue to represent an important source of cumulative impacts to the

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river.

Fishing Pressure

Many RIS are commercially or recreationally important, and are thus subject to effects from fishing pressure. In many cases, the commercial or recreational catches of RIS are regulated by Federal or State agencies or entities, but losses of some RIS continue to occur as the result of bycatch. The extent and magnitude of fishing pressure and its relationship to overall cumulative impacts to the aquatic resources of the lower Hudson River is difficult to determine because of the large geographic scale and the natural variation that exists in the system. Recent work by Barnthouse et al. (2008) has suggested that fishing pressure is contributing to the decline of some RIS in the lower Hudson River, but this could not be confirmed by the staff. The staff does acknowledge that fishing pressure (or the lack of it due to catch restrictions) has the potential to influence the freshwater, estuarine, and marine food webs present in the lower Hudson River and may contribute to cumulative impacts in the future.

Habitat Loss

As described in Section 2.2.5 of this draft SEIS, alterations to terrestrial, wetland, nearshore, and aquatic habitats have occurred in the Hudson River estuary since colonial times. During the colonization of the region, upland habitat alterations profoundly influenced watershed dynamics. The creation of dams and the filling or isolation of wetlands to support industrial activities have dramatically changed patterns of nutrients and sediment loading to the estuary. In addition, historic dredging activities altered aquatic environments and affected river flow patterns, and future activities, as described in Section 2.2.10 of this draft SEIS, may continue to influence the river. Finally, development along the shores of the Hudson has resulted in the loss or isolation of nearshore habitat, and the armoring of the shoreline in the lower portions of the river from Yonkers to the Battery has effectively eliminated nearshore habitat. The NRC staff recognizes that Federal, State, and local agencies, as well as many NGOs, are interested in restoring habitat lost during past development and notes that the identification of four locations along the lower Hudson River estuary for inclusion in the National Estuarine Research Reserve System in 1982 represents a important step in protecting and restoring important habitats.

Because habitat loss remains a concern, the NRC staff concludes that this stressor will continue to be an important contributor to cumulative impacts to the lower Hudson River.

Water and Sediment Quality

In general, there is evidence to conclude that the overall quality of water and sediment in the lower Hudson River is improving. Cleanup of polychlorinated biphenyls in stretches of the river above the Troy Dam continues, and upgrades to wastewater treatment facilities during the past 20 years have reduced the amount of untreated sewage discharged into the river and contributed to reductions in nutrients and an apparent increase in dissolved oxygen. Chemical contaminants continue to persist in the tissues of fish and invertebrates inhabiting the lower Hudson River, and the presence of nonpoint discharges of chemicals and constituents continues to be a concern of local, State, and Federal regulatory agencies and NGOs. The NRC staff concludes that the quality of water and sediment in the lower Hudson River will continue to be a concern and a potential contributor to cumulative impacts.

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Climate Change

The potential cumulative effects of climate change on the Hudson River watershed, whether from natural cycles or related to anthropogenic activities, could result in a variety of changes that would affect aquatic resources. The environmental factors of significance identified by Kennedy (1990) that could affect estuarine systems included sea level rise, temperature increase, salinity changes, and wind and water circulation changes. Changes in sea level could result in dramatic effects to nearshore communities, including the reduction or redistribution of submerged aquatic vegetation, changes to marsh communities, and influences to wetland areas adjacent to nearshore systems. Water temperature increases could affect spawning patterns or success, or influence the distribution of key RIS when cold-water species move northward while warm-water species become established in new habitats. Changes to river salinity and the presence of the salt front could influence the spawning and distribution of RIS and the range of exotic or nuisance species. Fundamental changes in precipitation could profoundly influence water circulation 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 on many levels. Kennedy (1990) also concluded that some fisheries and aquaculture enterprises might benefit from climate change, while others would suffer extensive economic losses.

The extent and magnitude of climate change impacts to the aquatic resources of the lower Hudson River are an important component of the cumulative assessment analyses and could be substantial.

Final Assessment of Cumulative Impacts on Aquatic Resources

Based on the NRC staff review, it is clear that Hudson River RIS are affected (some to a lesser degree than others) by multiple stressors. The NRC staff's analysis (Appendix H) demonstrated that the food web and abundance of RIS were noticeably altered, and many RIS appeared to be directly influenced by the operation of the IP2 and IP3 cooling system (e.g., HIGH strength of connection). The impacts of some of the stressors may be addressed by management actions (e.g., IP2 and IP3 cooling system operation, fishing pressure, and water quality) and some cannot (e.g., long-term impacts associated with climate change). Although the impacts associated with increased human populations and associated development of the Hudson River basin, climate change, redistribution of resources, and the presence of invasive species and disease cannot be quantitatively calculated, the cumulative impacts on aquatic resources have had destabilizing effects on Hudson River living resources, including threatened and endangered species (i.e., the net effect of all stressors destabilized some populations) and are considered by the NRC staff to be LARGE.

4.8.2 Cumulative Impacts on Terrestrial Resources

This section addresses past, present, and future actions that could result in cumulative adverse impacts on terrestrial resources, including wildlife populations, vegetation communities of uplands and riparian zones, wetlands, and land use. For purposes of this analysis, the geographic area considered consists of the IP2 and IP3 site, which encompasses its associated transmission line ROWs, and the surrounding region of the lower Hudson Valley.

The changes in land use associated with historical settlement and development of this region are described in Section 2.2.5.2 of this draft SEIS. During precolonial and colonial settlement

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by European immigrants, large areas of the forest that had almost completely covered the region were cleared for agriculture, and by 1880, 68 percent of the Hudson River watershed had become farmland. Also in the 19th century, major changes in land use occurred in the region in conjunction with the industrial revolution as human populations grew and houses, roads, railroads, bridges, and industrial facilities were constructed. These historical trends of increasing development and decreasing terrestrial habitat in the region continued through the 20th century to the present, resulting in large reductions in native forests and other habitats for terrestrial wildlife, increases in precipitation runoff due to impervious surfaces, and pollution (Swaney et al. 2006).

Before the historical clearing of land at the IP2 and IP3 site, the terrestrial communities of the area consisted mainly of upland and riparian forests (NRC 1975). The site was originally purchased in 1683 by a Dutch settler, who established a homestead there. By the latter 19th century, the north end of Indian Point was being surface mined for iron, and a lime kiln and blast furnace were located at the shoreline. By 1900 a brickyard existed on the site, and farming still occurred there. In 1920 an amusement park was built on the site. The park closed in 1956, and construction of the first commercial nuclear reactor in the United States then began at the site (Enercon 2007). Thus, the site had been largely cleared of forest and developed for various uses for well over a century before its development for power generation began in the second half of the 20th century. Power plant development resulted in over half of the site (134 ac (54.2 ha)) being covered by facilities and pavement, with forest having regenerated at the north end of the site where mining occurred historically. Remaining native forest habitat in central and southern portions of the site has been fragmented by roads, ROWs, parking areas, and other development, a phenomenon that has commonly occurred in the region.

Developed areas with impervious surfaces have increased precipitation runoff and reduced infiltration into the soil, thus reducing ground water recharge, altering streamflow, and increasing soil erosion. Maintenance of vegetation in ROWs and other developed areas, such as by mowing and spraying of herbicides, has altered the ecological communities in these areas by preventing natural succession. It also likely has resulted in increases in invasive species, such as Japanese knotweed (*Fallopia japonica*), which typically are more aggressive than native species in colonizing disturbed areas; increases in species that prefer edge habitat; and decreases in species that prefer interior forest habitat. Such effects from development within the IP2 and IP3 site contribute to cumulative impacts from similar effects on native ecological communities from other development in the region.

Land use data provide an indication of the impacts on terrestrial resources that have resulted from historical and ongoing development. Current land uses in the region are discussed by county in Section 2.2.8.3 of this draft SEIS. In Westchester County, based on 1992 data, forest was the predominant type of land cover (53 percent), followed by residential (30 percent), agricultural and recreational (7 percent), and commercial/industrial/transportation uses (3 percent) (Entergy 2007a). In four nearby counties in the lower Hudson Valley (Rockland, Orange, Putnam, and Dutchess), forest also was the predominant type of land cover, followed by residential or agricultural, and commercial/industrial/transportation land uses ranged from about 1 to 4 percent (Entergy 2007a). Thus, commercial, industrial, and transportation facilities, including the IP2 and IP3 site, have had a relatively small impact on the loss of native terrestrial forest habitats in the region compared to residential and agricultural development. The commercial, industrial, and transportation facilities that have impacted terrestrial resources in

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the region in addition to the IP2 and IP3 site include six power generation facilities on the Hudson River between RM 37 and 67 (RKM 60 to 97), highways, railways along both sides of the river, and manufacturing plants.

Although development of the site has contributed to cumulative impacts on terrestrial resources from historical and ongoing development in the region, portions of the site have been protected from development. The 70-ac (28-ha) forest community at the north end of the site has been and, under the proposed action, would continue to be preserved, providing a beneficial effect by reducing the potential for cumulative impacts from further loss of forests in the region. In conjunction with this onsite forest tract, public lands in the region also preserve forest habitat and have a beneficial cumulative impact on terrestrial resources. These lands include three State parks in Westchester County and a total of 22 others in Rockland, Orange, Putnam, and Dutchess Counties (Entergy 2007a), as well as forested lands of the New York State National Guard's Camp Smith and the U.S. Military Academy at West Point.

Ultimately, development of the IP2 and IP3 site for power generation contributed incrementally to a substantial, cumulative reduction in terrestrial resources resulting from other development activities in the region that have occurred since precolonial times. However, as discussed in Section 4.4.3 of this draft SEIS, there would be no population-related land use impacts attributable to IP2 and IP3 during the license renewal term beyond those already being experienced, and there would be no noticeable change in land use conditions in the vicinity of IP2 and IP3.

The NRC staff concludes that the impact of past, present, and reasonably foreseeable future actions in the region on terrestrial resources is considered LARGE relative to predevelopment conditions, and that much of this impact had occurred before the construction and operation of IP2 and IP3.

4.8.3 Cumulative Radiological Impacts

The radiological dose limits for protection of the public and workers have been developed by the NRC and EPA to address the cumulative impact of acute and long-term exposure to radiation and radioactive material. These dose limits are codified in 10 CFR Part 20 and 40 CFR Part 190. For the purpose of this analysis, the area within a 50-mi (80.4-km) radius of the IP2 and IP3 site was included. The radiological environmental monitoring program conducted by Entergy in the vicinity of the IP2 and IP3 site measures radiation and radioactive materials from all sources; therefore, the monitoring program measures cumulative radiological impacts. Within the 50-mi (80-km) radius of the IP2 and IP3 site there are no other nuclear power reactors or uranium fuel cycle facilities. The NRC staff reviewed the 1993 and 1994 radiological environmental monitoring data from the area around IP2 and IP3 reported by New York State; the data showed no adverse environmental impact. For the new issue identified by Entergy concerning the tritium leak into the Hudson River, the NRC staff also reviewed the information reported by Entergy, the NYSDEC and NYSDOH, and by the NRC. No adverse impacts were identified (Entergy 2007b, NYSDEC and NYSDOH 2008, NRC 2006b, NRC 2007b).

Radiation monitoring results for the 5-year period from 2002 to 2006 were reviewed as part of the cumulative impacts assessment. In Sections 2.2.7 and 4.3 of this draft SEIS, the NRC staff concluded that impacts of radiation exposure to the public and workers (occupational) from

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operation of IP2 and IP3 during the renewal term are SMALL. The NRC and the State of New York would regulate any future actions in the vicinity of the IP2 and IP3 site that could contribute to cumulative radiological impacts (Entergy 2003, 2004, 2005, 2006, 2007b).

Entergy has constructed an independent spent fuel storage installation (ISFSI) on the IP2 and IP3 site in 2008 for the storage of its spent fuel. The installation and monitoring of this facility is governed by NRC requirements in 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste." Radiation from this facility as well as from the operation of IP2 and IP3 must not exceed the radiation dose limits in 10 CFR Part 20, 40 CFR Part 190, and 10 CFR Part 72 (Entergy 2007a).

In addition, Entergy has indicated that it may replace IP2 and IP3 reactor vessel heads and CRDMs during the period of extended operation. Such an action is not expected to change the applicant's ability to maintain radiological doses to members of the public well within regulatory limits because the amount of radioactive liquid, gaseous, and solid waste is not expected to increase significantly (see Sections 2.1.4 and 2.2.7 of this draft SEIS for the detailed discussion).

For these reasons, the NRC staff concludes that cumulative radiological impacts are SMALL, as are the contribution to radiological impacts from continued operation of IP2 and IP3 and their associated ISFSI. The NRC and the State of New York will continue to regulate operation of IP2 and IP3 for radiological impacts.

4.8.4 Cumulative Socioeconomic Impacts

As discussed in Section 4.4 of this draft SEIS, continued operation of IP2 and IP3 during the license renewal term would have no impact on socioeconomic conditions in the region beyond those already being experienced. Since Entergy has indicated that it plans to hire no additional nonoutage workers during the license renewal term, overall expenditures and employment levels at IP2 and IP3 would be expected to remain relatively constant with no additional demand for permanent housing, public utilities, and public services. In addition, since employment levels and the value of IP2 and IP3 would not change, there would be no population and tax-revenue-related land use impacts. Also, there would be no disproportionately high and adverse health and environmental impacts on minority and low-income populations in the region.

Entergy has indicated that it may replace the IP2 and IP3 reactor vessel heads and CRDMs, and the decision to proceed with this replacement activity would be made based on future component inspection results (Entergy 2008b). Nevertheless, Entergy estimates that this replacement activity would require an increase in the number of refueling outage workers for up to 60 days during two separate refueling outages, one for each unit, 12 months apart (Entergy 2008b). These additional workers would create short-term increases in the demand for temporary (rental) housing, increased use of public water and sewer services, and transportation impacts on access roads in the immediate vicinity of IP2 and IP3. Since it is not certain if Entergy will replace the IP2 and IP3 reactor vessel heads and CRDMs, and given the short amount of time needed for this replacement activity, the cumulative effects of these replacement activities on socioeconomic conditions in the vicinity of IP2 and IP3 would not likely be noticeable. Also, there would be no long-term cumulative socioeconomic impacts after the reactor vessel heads and CRDMs are replaced.

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In general, the region surrounding IP2 and IP3 has experienced growing population, increasing economic activity and tax revenue, and changes in demographics over time. These effects in the region have been LARGE, though the contribution of IP2 and IP3 to these effects have been SMALL, except, in some cases, locally. Additionally, development in the region has had a significant effect on historical and archaeological resources, which could be LARGE, as the region is home to significant historic and prehistoric resources (as noted in 4.4.5, however, continued operation of the plant would only have SMALL effects on historic and archaeological resources).

4.8.5 Cumulative Impacts on Ground Water Use and Quality

In 2005 tritium was located beneath the IP2 and IP3 site. During a subsequent subsurface monitoring program at the site, radioactive forms of cesium, cobalt, nickel, and strontium also were found. The radiological impact of these abnormal leaks to the ground water is discussed in Section 2.2.7 of this draft SEIS, and referenced in Sections 4.5 and 4.7.

The topography of the site and the foundation drains around the structures result in a flow regime that transports ground water towards the Hudson River. As a result, the contaminated ground water will be transported to the Hudson River and not off site in a direction that it might be captured by an offsite ground water user. The results of monitoring programs support this conclusion.

Because the water travels off site and into the Hudson River, there are no users for onsite ground water. Any effects from the plant, previous development, or future development on site will likely remain limited to effects on ground water transiting the site to the Hudson River, and thus, are likely to be limited.

On the basis of the topography of the site, the characteristics of the subsurface media, location of the plant relative to the Hudson River, recent ground water monitoring observations, and the fact that there are no users for the site's ground water, the NRC staff concludes that the cumulative impact on the site's ground water use and quality are SMALL.

4.8.6 Conclusions Regarding Cumulative Impacts

The NRC staff considered the potential impacts resulting from the operation of IP2 and IP3 and resulting from other past, present, and reasonably foreseeable future actions in the vicinity. The NRC staff's determination is that the cumulative impacts to the environment surrounding IP2 and IP3 from past and present human activities (beyond impacts from IP2 and IP3) have generally been LARGE and could continue to be LARGE in some issue areas. Future development is likely to continue to affect these resources.

4.9 Summary of Impacts of Operations during the Renewal Term

The NRC staff did not identify any information that is both new and significant related to any of the applicable Category 1 issues associated with the operation of IP2 and IP3 during the renewal term, including information related to ground water contamination at Indian Point. Consequently, the NRC staff concludes that the environmental impacts associated with these issues are bounded by the impacts described in the GEIS. For each of these issues, the GEIS

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concluded that the impacts would be SMALL and that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

Thirteen of the site-specific environmental issues identified in the GEIS related to operational impacts, and postulated accidents during the renewal term are discussed in detail in this draft SEIS. These include 11 Category 2 issues and two uncategorized issues (environmental justice and the chronic effects of EMFs). The NRC staff did not evaluate the chronic effects of EMFs because research is continuing in the area and no scientific consensus on human health impacts exists. The NRC staff will evaluate severe accident mitigation alternatives in Chapter 5.

For 6 of the remaining 10 Category 2 issues and environmental justice, the NRC staff concluded that the potential impacts of continued plant operation during the license renewal period on these issues are of SMALL significance in the context of the standards set forth in the GEIS. For four of these issues, the NRC staff concluded that the impacts of continued operation would have a significant effect. On the issue of heat shock on the aquatic ecology, the NRC staff concludes that effects are of SMALL to MODERATE significance, given uncertainty about actual thermal effects of the plant. The NRC staff evaluated the combined effects of entrainment and impingement on aquatic life and found the impacts to range from SMALL to LARGE, depending on the species. Finally, the NRC staff found that impacts to threatened and endangered species could range from SMALL to LARGE but that existing data make it difficult for staff to assign a single impact level. Further sampling for threatened and endangered species at IP2 and IP3 could reduce this uncertainty.

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5.0 ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

Environmental issues associated with postulated accidents are discussed in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999).[1] The GEIS includes a determination of whether the analysis of the environmental issues could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, 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 collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(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.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1 and, therefore, additional plant-specific review of these issues is required.

This chapter describes the environmental impacts from postulated accidents that might occur during the license renewal term.

5.1 Postulated Plant Accidents

Two classes of accidents are evaluated in the GEIS. These are design-basis accidents (DBAs) and severe accidents, as discussed below.

5.1.1 Design-Basis Accidents

In order to receive U.S. Nuclear Regulatory Commission (NRC) approval to operate a nuclear power facility, an applicant for an initial operating license must submit a safety analysis report (SAR) as part of its application. The SAR presents the design criteria and design information for the proposed reactor and comprehensive data on the proposed site. The SAR also discusses various hypothetical accident situations and the safety features that are provided to prevent and mitigate accidents. The NRC staff reviews the application to determine whether the plant

[1] The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the GEIS include the GEIS and its Addendum 1.

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design meets the Commission's regulations and requirements and includes, in part, the nuclear plant design and its anticipated response to an accident.

DBAs are those accidents that both the licensee and the NRC staff evaluate to ensure that the plant can withstand normal and abnormal transients, as well as a broad spectrum of postulated accidents, without undue hazard to the health and safety of the public. A number of these postulated accidents are not expected to occur during the life of the plant, but are evaluated to establish the design basis for the preventive and mitigative safety systems of the facility. The acceptance criteria for DBAs are described in Title 10, Part 50, "Domestic Licensing of Production and Utilization Facilities," of the *Code of Federal Regulations* (10 CFR Part 50) and 10 CFR Part 100, "Reactor Site Criteria."

The environmental impacts of DBAs are evaluated during the initial licensing process, and the ability of the plant to withstand these accidents is demonstrated to be acceptable before issuance of the operating license. The results of these evaluations are found in licensing documentation such as the applicant's final safety analysis report, the NRC staff's safety evaluation report, the final environmental statement (FES), and Section 5.1 of this draft supplemental environmental impact statement (SEIS). A licensee is required to maintain the acceptable design and performance criteria throughout the life of the plant, including any extended-life operation. The consequences for these DBAs are evaluated for the hypothetical maximally exposed individual. Changes in the plant's surroundings, including local population, will not affect the evaluation for the maximally exposed individual. Because of the requirements that continuous acceptability of the consequences and aging management programs be in effect for license renewal, the environmental impacts as calculated for DBAs should not differ significantly from initial licensing assessments over the life of the plant, including the period of extended operation. Accordingly, the design of the plant relative to DBAs during the extended period is considered to remain acceptable, and the environmental impacts of those accidents were not examined further in the GEIS.

The Commission has determined that the environmental impacts of DBAs are of SMALL significance for all plants because the plants were designed to successfully withstand these accidents. Therefore, for the purposes of license renewal, DBAs are designated as a Category 1 issue in Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." The early resolution of the DBAs makes them a part of the current licensing basis (CLB) of the plant; the CLB of the plant, which is maintained by the licensee under its current license, will continue to be maintained under a renewed license in accordance with 10 CFR 54.33, "Continuation of CLB and Conditions of Renewed License." Therefore, under the provisions of 10 CFR 54.30, "Matters Not Subject to a Renewal Review," the CLB is not subject to review under license renewal. This issue, applicable to Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3), is listed in Table 5-1.

Table 5-1. Category 1 Issues Applicable to Postulated Accidents during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
POSTULATED ACCIDENTS	

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ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
Design-basis accidents	5.3.2; 5.5.1

Based on information in the GEIS, the Commission found the following:

> The NRC staff has concluded that the environmental impacts of design-basis accidents are of small significance for all plants.

Entergy Nuclear Operations, Inc. (Entergy), stated in the IP2 and IP3 environmental report (ER) (Entergy 2007a) that it is not aware of any new and significant information associated with the renewal of the IP2 and IP3 operating licenses. The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts related to DBAs beyond those discussed in the GEIS.

5.1.2 Severe Accidents

Severe nuclear accidents are those that are more severe than DBAs because they could result in substantial damage to the reactor core, regardless of offsite consequences. In the GEIS, the NRC staff assessed the impacts of severe accidents using the results of existing analyses and site-specific information to conservatively predict the environmental impacts of severe accidents for each plant during the renewal period.

Severe accidents initiated by external phenomena, such as tornadoes, floods, earthquakes, fires, and sabotage, traditionally have not been discussed in quantitative terms in FESs and were not specifically considered for IP2 and IP3 in the GEIS. However, in the GEIS, the NRC staff did evaluate existing impact assessments performed by the NRC and by the industry at 44 nuclear plants in the United States and concluded that the risk from beyond-design-basis earthquakes at existing nuclear power plants is SMALL. The GEIS for license renewal documents a discretionary analysis of acts of sabotage in connection with license renewal, and concluded that the core damage and radiological release from such acts would be no worse than the damage and release expected from internally initiated events. In the GEIS, the Commission concluded that the risk from sabotage and beyond-design-basis earthquakes at existing nuclear power plants is small and, additionally, that the risks from other external events are adequately addressed by a generic consideration of internally initiated severe accidents (see Volume 1 of the GEIS, page 5-18).

Based on information in the GEIS, the Commission found the following:

> 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.

Therefore, the Commission has designated mitigation of severe accidents as a Category 2 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. This issue, applicable to IP2 and IP3, is listed in Table 5-2.

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Table 5-2. Category 2 Issues Applicable to Postulated Accidents during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
	POSTULATED ACCIDENTS		
Severe accidents	5.3.3; 5.3.3.2; 5.3.3.3; 5.3.3.4; 5.3.3.5; 5.4; 5.5.2	L	5.2

The NRC staff has not identified any new and significant information with regard to the consequences from severe accidents during its independent review of the IP2 and IP3 ER (Entergy 2007a), the site visit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts of severe accidents beyond those discussed in the GEIS. However, in accordance with 10 CFR 51.53(c)(3)(ii)(L), the NRC staff has reviewed severe accident mitigation alternatives (SAMAs) for IP2 and IP3. The results of its review are discussed in Section 5.2 of this draft SEIS.

5.2 Severe Accident Mitigation Alternatives

As required by 10 CFR 51.53(c)(3)(ii)(L), license renewal applicants must consider alternatives to mitigate severe accidents if the staff has not previously evaluated SAMAs for the applicant's plant in an environmental impact statement (EIS), or related supplement, or in an environmental assessment. The purpose of this consideration is to ensure that plant changes (i.e., hardware, procedures, and training) with the potential for improving severe accident safety performance are identified and evaluated. SAMAs have not been previously considered for IP2 and IP3; therefore, the remainder of Chapter 5 addresses those alternatives.

5.2.1 Introduction

This section presents a summary of the SAMA evaluation for IP2 and IP3, conducted by Entergy, and the NRC staff's review of that evaluation. The NRC staff performed its review with contract assistance from Information Systems Laboratories, Inc. The NRC staff's review is available in full in Appendix G to this draft SEIS; the SAMA evaluation is available in full in Entergy's ER.

The SAMA evaluation for IP2 and IP3 was conducted using a four-step approach. In the first step, Entergy quantified the level of risk associated with potential reactor accidents using the plant-specific probabilistic safety assessment (PSA) and other risk models.

In the second step, Entergy examined the major risk contributors and identified possible ways (i.e., SAMAs) of reducing that risk. Common ways of reducing risk are changes to components, systems, procedures, and training. Entergy initially identified 231 and 237 potential SAMAs for IP2 and IP3, respectively. For each unit, Entergy performed an initial screening in which it eliminated SAMAs that are not applicable to IP2 and IP3 because of design differences, have already been implemented at IP2 and IP3, or are similar in nature and could be combined with another SAMA candidate. This screening reduced the list of potential SAMAs to 68 for IP2 and

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62 for IP3.

In the third step, Entergy estimated the benefits and the costs associated with each of the remaining SAMAs. Estimates were made of how much each SAMA could reduce risk. Those estimates were developed in terms of dollars in accordance with NRC guidance for performing regulatory analyses (NRC 1997). The cost of implementing the proposed SAMAs also was estimated.

Finally, in the fourth step, the costs and benefits of each of the remaining SAMAs were compared to determine whether the SAMA was cost beneficial, meaning the benefits of the SAMA were greater than the cost (a positive cost benefit). Entergy concluded in its ER that several of the SAMAs evaluated for each unit are potentially cost beneficial (Entergy 2007b). However, in response to NRC staff inquiries regarding estimated benefits for certain SAMAs and lower cost alternatives, several additional potentially cost-beneficial SAMAs were identified (Entergy 2008a). The NRC staff identifies potentially cost-beneficial SAMAs in Section 5.2.5.

The potentially cost-beneficial SAMAs do not relate to adequately managing the effects of aging during the period of extended operation; therefore, they need not be implemented as part of license renewal pursuant to 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." Entergy's SAMA analyses and the NRC's review are discussed in more detail below.

5.2.2 Estimate of Risk

Entergy submitted an assessment of SAMAs for IP2 and IP3 as part of the ER (Entergy 2007b). This assessment was based on the most recent IP2 and IP3 PSA available at that time, a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) computer program, and insights from the IP2 and IP3 individual plant examination (Con Ed 1992; NYPA 1994) and individual plant examination of external events (Con Ed 1995 and NYPA 1997).

The baseline core damage frequency (CDF) for the purpose of the SAMA evaluation is approximately 1.79×10^{-5} per year for IP2 and 1.15×10^{-5} per year for IP3. The CDF values are based on the risk assessment for internally initiated events. Entergy did not include the contributions from external events within the IP2 and IP3 risk estimates; however, it did perform separate assessments of the CDF from external events and did account for the potential risk reduction benefits associated with external events by multiplying the estimated benefits for internal events by a factor of approximately 3.8 for IP2 and 5.5 for IP3 (as discussed in Appendix G, Sections G.2.2 and G.6.2). The breakdown of CDF by initiating event for IP2 and IP3 is provided in Table 5-3.

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Table 5-3. IP2 and IP3 Core Damage Frequency

Initiating Event	IP2		IP3	
	CDF (Per Year)	% Contribution to CDF	CDF (Per Year)	% Contribution to CDF
Loss of offsite power[1]	$6.7x10^{-6}$	38	$1.2x10^{-7}$	1
Internal flooding	$4.7x10^{-6}$	26	$2.2x10^{-6}$	20
Loss-of-coolant accident (LOCA)	$1.5x10^{-6}$	8	$2.2x10^{-6}$	19
Transients[1]	$1.2x10^{-6}$	7	$8.5x10^{-7}$	7
Anticipated transient without scram	$9.9x10^{-7}$	6	$1.5x10^{-6}$	13
Station blackout	$8.5x10^{-7}$	5	$7.2x10^{-7}$	6
Steam generator tube rupture	$7.2x10^{-7}$	4	$1.6x10^{-6}$	14
Loss of component cooling water	$5.8x10^{-7}$	3	$1.1x10^{-7}$	<1
Loss of nonessential service water interfacing systems LOCA	$3.0x10^{-7}$	2	$2.8x10^{-7}$	2
Reactor vessel rupture	$1.5x10^{-7}$	<1	$1.5x10^{-7}$	1
Loss of 125 volts direct current power	$1.0x10^{-7}$	<1	$1.0x10^{-7}$	<1
Total loss of service water system	$5.8x10^{-8}$	<1	$1.0x10^{-6}$	9
Loss of essential service water	$4.4x10^{-8}$ $1.9x10^{-10}$	<1 <1	$5.4x10^{-7}$ $1.9x10^{-8}$	5 <1
Total CDF (internal events)	**$1.79x10^{-5}$**	**100**	**$1.15x10^{-5}$**	**100**

[1]Contributions from SBO and ATWS events are noted separately and not included in the reported values for loss of offsite power or transients.

As shown in Table 5-3, for IP2, loss of offsite power sequences, including station blackout (SBO) events, and internal flooding initiators are the dominant contributors to CDF. For IP3, internal flooding initiators, loss-of-coolant accidents (LOCAs), steam generator tube rupture (SGTR) events, and anticipated transient without scram (ATWS) events are the dominant contributors to CDF. The differences in the CDF contributions are attributed, in large part, to several significant differences between the IP2 and IP3 units.

Entergy estimated the dose to the population within 80 kilometers (50 miles) of the IP2 and IP3 site to be approximately 0.22 person-sievert (Sv) (22 person-rem) per year for IP2, and 0.24 Sv (24 person-rem) per year for IP3. The breakdown of the total population dose by containment failure mode is summarized in Table 5-4. SGTR events and late containment failures, caused by gradual overpressurization by steam and noncondensable gases, dominate the population dose risk for both units.

The NRC staff has reviewed Entergy's data and evaluation methods and concludes that the quality of the risk analyses is adequate to support an assessment of the risk reduction potential for candidate SAMAs. Accordingly, the staff based its assessment of offsite risk on the CDFs

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and offsite doses reported by Entergy.

Table 5-4. Breakdown of Population Dose by Containment Failure Mode

Containment Failure Mode	IP2		IP3	
	Population Dose (Person-Rem[1] Per Year)	% Contribution	Population Dose (Person-Rem[1] Per Year)	% Contribution
Intact Containment	<0.1	<1	<0.1	<1
Basemat Melt-through	1.1	5	0.6	3
Gradual Overpressure	7.4	34	4.4	18
Late Hydrogen Burns	0.9	4	0.6	2
Early Hydrogen Burns	2.1	10	0.8	3
In-Vessel Steam Explosion	0.1	1	0.1	0
Reactor Vessel Rupture	1.0	5	0.4	2
Interfacing System LOCA	1.6	7	1.1	4
SGTR	7.7	35	16.6	68
Total	**22.0**	**100**	**24.3**	**100**

[1]One person-rem = 0.01 person-sievert

5.2.3 Potential Plant Improvements

Once the dominant contributors to plant risk were identified, Entergy searched for ways to reduce that risk. In identifying and evaluating potential SAMAs, Entergy considered insights from the plant-specific PSA and SAMA analyses performed for other operating plants that have submitted license renewal applications. Entergy identified 231 and 237 potential risk-reducing improvements (SAMAs) to plant components, systems, procedures, and training for IP2 and IP3, respectively.

For IP2, Entergy removed all but 68 of the SAMAs from further consideration because they are not applicable to IP2 as a result of design differences, have already been implemented at IP2, or are similar in nature and could be combined with another SAMA candidate. For IP3, all but 62 of the SAMAs were removed from further consideration based on similar criteria. A detailed cost-benefit analysis was performed for each of the remaining SAMAs.

The staff concludes that Entergy used a systematic and comprehensive process for identifying potential plant improvements for IP2 and IP3, and that the set of potential plant improvements identified by Entergy is reasonably comprehensive and, therefore, acceptable.

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5.2.4 Evaluation of Risk Reduction and Costs of Improvements

Entergy evaluated the risk-reduction potential of the remaining candidate SAMAs that were applicable to each unit (68 for IP2 and 62 for IP3). The SAMA evaluations were performed using realistic assumptions with some conservatism.

Entergy estimated the costs of implementing the candidate SAMAs through the application of engineering judgment and the use of other licensees' estimates for similar improvements. The cost estimates conservatively did not include the cost of replacement power during extended outages required to implement the modifications, nor did they account for inflation.

The staff reviewed Entergy's basis for calculating the risk reduction for the various plant improvements and concludes that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the staff based its estimates of averted risk for the various SAMAs on Entergy's risk reduction estimates.

The staff reviewed the basis for the applicant's cost estimates. For certain improvements, the staff also compared the cost estimates to estimates developed elsewhere for similar improvements, including estimates developed as part of other licensees' analyses of SAMAs for operating reactors and advanced light-water reactors. The staff found the cost estimates to be reasonable and generally consistent with estimates provided in support of other plants' analyses.

The staff concludes that the risk reduction and the cost estimates provided by Entergy are sufficient and appropriate for use in the SAMA evaluation.

5.2.5 Cost-Benefit Comparison

The cost-benefit analysis performed by Entergy was based primarily on NUREG/BR-0184, "Regulatory Analysis Technical Evaluation Handbook" (NRC 1997) and was executed consistent with this guidance. NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission" (NRC 2004), has recently been revised to reflect the agency's revised policy on discount rates. Revision 4 of NUREG/BR-0058 states that two sets of estimates should be developed—one at 3 percent and one at 7 percent (NRC 2004). Entergy provided both sets of estimates (Entergy 2007b).

As described in Section G.6.1, Entergy identified 10 potentially cost-beneficial SAMAs (5 for IP2 and 5 for IP3) in the baseline analysis (using a 7-percent discount rate) and sensitivity analysis (using a 3-percent discount rate) contained in the ER. Based on consideration of analysis uncertainties, Entergy identified two additional potentially cost-beneficial SAMAs for IP2 in the ER (IP2 SAMAs 44 and 56).

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In response to an NRC staff request, Entergy provided the results of a revised uncertainty analysis in which the impact of lost tourism and business was accounted for in the baseline analysis (rather than as a separate sensitivity case) (Entergy 2008a). The revised uncertainty analysis resulted in the identification of two additional potentially cost-beneficial SAMAs for IP2 (IP2 SAMAs 9 and 53) and one additional potentially cost-beneficial SAMA for IP3 (IP3 SAMA 53).

The potentially cost-beneficial SAMAs for IP2 include the following:

- SAMA 9—Create a reactor cavity flooding system to reduce the impact of core-concrete interaction from molten core debris following core damage and vessel failure (cost beneficial in revised analysis, with uncertainties).
- SAMA 28—Provide a portable diesel-driven battery charger to improve direct current (dc) power reliability. Safety-related disconnect would be used to change a selected battery. This modification would enhance the long-term operation of the turbine-driven auxiliary feed water (AFW) pump on battery depletion.
- SAMA 44—Use fire water as backup for steam generator inventory to increase the availability of steam generator water supply to ensure adequate inventory for the operation of the turbine-driven AFW pump during SBO events (cost beneficial with uncertainties).
- SAMA 53—Keep both pressurizer power-operated relief valve block valves open. This modification would reduce the CDF contribution from loss of secondary heat sink by improving the availability of feed and bleed (cost beneficial in revised analysis, with uncertainties).
- SAMA 54—Install a flood alarm in the 480-volt (V) alternating current (ac) switchgear room to mitigate the occurrence of internal floods inside the 480-V ac switchgear room.
- SAMA 56—Keep residual heat removal (RHR) heat exchanger discharge valves, motor-operated valves 746 and 747, normally open. This procedure change would reduce the CDF contribution from transients and LOCAs (cost beneficial with uncertainties).
- SAMA 60—Provide added protection against flood propagation from stairwell 4 into the 480-V ac switchgear room to reduce the CDF contribution from flood sources within stairwell 4 adjacent to the 480-V ac switchgear room.
- SAMA 61—Provide added protection against flood propagation from the deluge room into the 480-V ac switchgear room to reduce the CDF contribution from flood sources within the deluge room adjacent to the 480-V ac switchgear room.
- SAMA 65—Upgrade the alternate safe shutdown system to allow timely restoration of reactor coolant pump seal injection and cooling from events that cause loss of power from the 480-V ac vital buses.

The potentially cost-beneficial SAMAs for IP3 include the following:

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- SAMA 30—Provide a portable diesel-driven battery charger to improve dc power reliability. Safety-related disconnect would be used to change a selected battery. This modification would enhance the long-term operation of the turbine-driven AFW pump on battery depletion.
- SAMA 52—Proceduralize opening the city water supply valve for alternative AFW system pump suction to enhance the availability of AFW system.
- SAMA 53—Install an excess flow valve to reduce the risk associated with hydrogen explosions inside the turbine building or primary auxiliary building (cost beneficial in revised analysis, with uncertainties).
- SAMA 55—Provide the capability of powering one safety injection pump or RHR pump using the Appendix R diesel (MCC 312A) to enhance reactor cooling system injection capability during events that cause loss of power from the 480-V ac vital buses.
- SAMA 61—Upgrade the alternate safe-shutdown system to allow timely restoration of reactor coolant pump seal injection and cooling from events that cause loss of power from the 480-V ac vital buses.
- SAMA 62—Install a flood alarm in the 480-V ac switchgear room to mitigate the occurrence of internal floods inside the 480-V ac switchgear room.

In response to an NRC staff inquiry regarding estimated benefits for certain SAMAs and lower cost alternatives, one additional potentially cost-beneficial SAMA was identified (applicable to SGTR events in both units; unnumbered for each unit because the applicant did not initially identify them), and one SAMA that was previously identified as potentially cost beneficial was found to be no longer cost beneficial based on correction of an error in the ER (IP3 SAMA 30).

The staff concludes that, with the exception of the potentially cost-beneficial SAMAs discussed above, the costs of the SAMAs evaluated would be higher than the associated benefits.

5.2.6 Conclusions

The staff reviewed Entergy's analysis and concluded that the methods used, and the implementation of those methods, were sound. The treatment of SAMA benefits and costs support the general conclusion that the SAMA evaluations performed by Entergy are reasonable and sufficient for the license renewal submittal. Although the treatment of SAMAs for external events was somewhat limited, the likelihood of there being cost-beneficial enhancements in this area was minimized by improvements that have been realized as a result of the IPEEE process and inclusion of a multiplier to account for external events.

Based on its review of the SAMA analysis, the staff concurs with Entergy's identification of areas in which risk can be further reduced in a cost-beneficial manner through the implementation of all or a subset of potentially cost-beneficial SAMAs. Given the potential for cost-beneficial risk reduction, the staff considers that further evaluation of these SAMAs by Entergy is warranted. However, none of the potentially cost-beneficial SAMAs relate to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of the license renewal pursuant to 10 CFR Part 54.

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5.3 References

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy,* Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 54. Code of Federal Regulations, Title 10, *Energy,* Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."

10 CFR Part 100. Code of Federal Regulations, Title 10, *Energy,* Part 100, "Reactor Site Criteria."

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Consolidated Edison (Con Ed). 1995. Letter from Stephen E. Quinn to U.S. Nuclear Regulatory Commission, Subject: Final Response to Generic Letter 88-20, Supplement 4: Submittal of Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities, Indian Point Unit No. 2, December 6, 1995.

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Entergy Nuclear Operations, Inc. (Entergy). 2008. Letter from Fred Dacimo to U.S. Nuclear Regulatory Commission, Subject: Reply to Request for Additional Information Regarding License Renewal Application—Severe Accident Mitigation Alternatives Analysis, NL-08-028, May 22, 2008. ADAMS Accession No. ML080420264.

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Nuclear Regulatory Commission (NRC). 1996. "Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants." NUREG-1437, Volumes 1 and 2, Washington, DC.

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Nuclear Regulatory Commission (NRC). 1997. "Regulatory Analysis Technical Evaluation Handbook." NUREG/BR-0184, Washington, DC.

Nuclear Regulatory Commission (NRC). 1999. "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, Washington, DC.

Nuclear Regulatory Commission (NRC). 2004. "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission." NUREG/BR-0058, Rev. 4, Washington, DC. ADAMS Accession No. ML042820192.

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6.0 ENVIRONMENTAL IMPACTS OF THE URANIUM FUEL CYCLE AND SOLID WASTE MANAGEMENT

Environmental issues associated with the uranium fuel cycle and solid waste management are discussed in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999.)[1] The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, 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 collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(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.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1; therefore, additional plant-specific review of these issues is required.

This chapter addresses the issues that are related to the uranium fuel cycle and solid waste management that are listed in Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51) and are applicable to the Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3). The generic potential radiological and nonradiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes are described in detail in the GEIS based, in part, on the generic impacts provided in 10 CFR 51.51(b), Table S-3, "Table of Uranium Fuel Cycle Environmental Data," and 10 CFR 51.52(c), Table S-4, "Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor." The U.S. Nuclear Regulatory Commission (NRC) staff also addresses the impacts from radon-222 and technetium-99 in the GEIS.

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[1] The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the GEIS include the GEIS and its Addendum 1.

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6.1 The Uranium Fuel Cycle

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to IP2 and IP3 from the uranium fuel cycle and solid waste management are listed in Table 6-1.

Table 6-1. Category 1 Issues Applicable to the Uranium Fuel Cycle and Solid Waste Management during the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
URANIUM FUEL CYCLE AND WASTE MANAGEMENT	
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste)	6.1; 6.2.1; 6.2.2.1; 6.2.2.3; 6.2.3; 6.2.4; 6.6
Offsite radiological impacts (collective effects)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6
Offsite radiological impacts (spent fuel and high-level waste disposal)	6.1; 6.2.2.1; 6.2.2.2; 6.2.3; 6.2.4; 6.6
Nonradiological impacts of the uranium fuel cycle	6.1; 6.2.2.6; 6.2.2.7; 6.2.2.8; 6.2.2.9; 6.2.3; 6.2.4; 6.6
Low-level waste storage and disposal	6.1; 6.2.2.2; 6.4.2; 6.4.3; 6.4.4
Mixed waste storage and disposal	6.1; 6.4.5; 6.6
Onsite spent fuel	6.1; 6.4.6; 6.6
Nonradiological waste	6.1; 6.5; 6.6
Transportation	6.1; 6.3, Addendum 1; 6.6

Entergy Nuclear Operations, Inc. (Entergy), stated in the IP2 and IP3 environmental report (ER) (Entergy 2007) that it is not aware of any new and significant information associated with the renewal of the IP2 and IP3 operating licenses, though it did identify leaks to ground water as a potentially new issue. The NRC staff addressed this issue in Sections 2.2.7, 4.3, and 4.5 of this draft supplemental environmental impact statement (SEIS). In Section 4.5, the NRC staff concludes that the abnormal liquid releases (leaks) discussed by Entergy in its ER, while new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20 and are not considered to have a significant impact on plant workers, the public, or the environment (i.e., while the information related to spent fuel pool leakage is new, it is not significant). The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER (Entergy 2007), the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the NRC staff concluded in the GEIS that the impacts are SMALL (except for the collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal, as discussed below) and that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

A brief description of the NRC staff's review and the GEIS conclusions, as codified in Table B-1 of 10 CFR Part 51, for each of these issues follows:

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- Off-site radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste). Based on information in the GEIS, the Commission found the following:

  Off-site impacts of the uranium fuel cycle have been considered by the Commission in Table S-3 of this part (10 CFR 51.51(b)). Based on information in the GEIS, impacts on individuals from radioactive gaseous and liquid releases including radon-222 and technetium-99 are small.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no offsite radiological impacts (individual effects) of the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Off-site radiological impacts (collective effects). Based on information in the GEIS, the Commission found the following:

  The 100 year environmental dose commitment to the United States (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 one 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 of the uncertainty, some judgement as to the National Environmental Policy Act of 1969, as amended (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.

The NRC staff has not identified any new and significant information during its independent

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review of the IP2 and IP3 ER, the NRC staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no offsite radiological impacts (collective effects) from the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Offsite radiological impacts (spent fuel and high-level waste disposal). Based on information in the GEIS, the Commission found the following:

  For the high level waste and spent fuel disposal component of the fuel cycle, 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, "Technical Bases for Yucca Mountain Standards" (NAS 1995), 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 (mrem) (1 mSv) 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 mrem 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 mrem (1 mSv) per year. The lifetime individual risk from 100 mrem annual dose limit is about 3×10^{-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 U.S. Department of Energy (DOE) in the "Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste," October 1980 (DOE 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

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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. Reporting performance standards that will be required by EPA are expected to result in releases and associated health consequences in the range between 10 and 100 premature cancer deaths with an upper limit of 1,000 premature cancer deaths world-wide for a 100,000 metric ton (MT) repository.

Nevertheless, despite all of 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.

On February 15, 2002, based on a recommendation by the Secretary of the DOE, the President recommended the Yucca Mountain site for the development of a repository for the geologic disposal of spent nuclear fuel and HLW. The U.S. 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 Stat. 735 designates Yucca Mountain as the repository for spent nuclear waste.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no offsite radiological impacts related to spent fuel and high-level waste disposal during the renewal term beyond those discussed in the GEIS.

- Nonradiological impacts of the uranium fuel cycle. Based on information in the GEIS, the Commission found the following:

  The nonradiological impacts of the uranium fuel cycle resulting from the renewal of an operating license for any plant are found to be small.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the NRC staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no

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nonradiological impacts of the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Low-level waste storage and disposal. Based on information in the GEIS, the Commission found 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 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.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts of low-level waste storage and disposal associated with the renewal term beyond those discussed in the GEIS.

- Mixed waste storage and disposal. Based on information in the GEIS, the Commission found 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 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.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts of mixed waste storage and disposal associated with the renewal term beyond those discussed in the GEIS.

- Onsite spent fuel. Based on information in the GEIS, the Commission found the following:

  The expected increase in the volume of spent fuel from an additional 20 years of

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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.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts of onsite spent fuel associated with license renewal beyond those discussed in the GEIS.

- Nonradiological waste. Based on information in the GEIS, the Commission found the following:

  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.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no nonradiological waste impacts during the renewal term beyond those discussed in the GEIS.

- Transportation. Based on information contained in the GEIS, the Commission found the following:

  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 megawatt-days per metric ton of uranium (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.

IP2 and IP3 meet the fuel-enrichment and burnup conditions set forth in Addendum 1 to the GEIS. The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts of transportation associated with license renewal beyond those discussed in the GEIS.

There are no Category 2 issues for the uranium fuel cycle and solid waste management.

6.2 Greenhouse Gas Emissions

6.2.1 Introduction

The NRC staff received many comments during the scoping period from individuals and groups

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regarding the impact of the proposed relicensing of IP2 and IP3 on the release of carbon dioxide (CO_2) and other greenhouse gas (GHG) emissions relative to potential alternative energy sources, including fossil fuels, renewable energy sources, and conservation programs.

6.2.2 IP2 and IP3

The NRC staff has not identified any studies specifically addressing GHGs produced by IP2 and IP3 or their fuel cycles. Although Entergy developed a study identifying gas emissions that would result if IP2 and IP3 were to be decommissioned and their generating capacity replaced with fossil-fuel based sources (Entergy Nuclear Northeast 2002), Entergy did not evaluate GHG emissions related to the existing facility. This study evaluated emissions of CO_2, sulfur dioxide, nitrogen oxides, particulates (i.e., PM_{10}), carbon monoxide, and volatile organic compounds (VOCs). The study was intended as an evaluation of the impact of IP2 and IP3 shutdown on air quality in the local New York City area, rather than an evaluation of the impact of IP2 and IP3 shutdown on global GHG emissions.

6.2.3 GEIS

The GEIS provided only qualitative discussions regarding the GHG impacts of the nuclear fuel cycle. In the analysis of potential alternatives to nuclear power plant relicensing, the GEIS referenced CO_2 emissions as one of the substantial operating impacts associated with new coal-fired and oil-fired power plants, although no direct quantitative assessment of GHG emissions was presented. The GEIS also did not address GHG impacts of the nuclear fuel cycle relative to other potential alternatives, such as natural gas, renewable energy sources, or conservation programs.

6.2.4 Other Studies

Since the development of the GEIS, extensive further research into the relative volumes of GHGs emitted by nuclear and other electricity generating methods has been performed. In support of the analysis for this draft SEIS, the NRC staff performed a survey of the recent literature on the subject. Based on this survey, the NRC staff found that estimates and projections of the carbon footprint of the nuclear power lifecycle vary widely, and considerable debate exists regarding the relative impacts of nuclear and other electricity generation methods on GHG emissions. These recent studies take two different forms:

(1) qualitative discussions of the potential use of nuclear power to address GHG emissions and global warming

(2) technical analyses and quantitative estimates of the actual amount of GHGs generated by the nuclear fuel cycle

6.2.5 Qualitative

The qualitative studies primarily consist of broad, large-scale public policy or investment evaluations of whether an expansion of nuclear power is likely to be a technically, economically, and/or politically feasible means of achieving global GHG reductions. Examples of the studies that commenters referenced during the scoping period or that the NRC staff identified during the

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subsequent literature search include the following:

- Studies conducted to evaluate whether 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 (Schneider 2000; IAEA 2000; NEA 2002; and NIRS/WISE 2005). Ultimately, the parties did not approve nuclear power as a component under the Clean Development Mechanism (CDM), but not because of concerns about GHGs from the nuclear fuel cycle (NEA 2002). Instead, it was eliminated from consideration for the CDM because it was not considered to meet the criterion of helping developing nations achieve sustainable development because of safety and waste disposal concerns (NEA 2002).
- Analyses developed to assist governments (including the U.S. Government) in making long-term investment and public policy decisions in nuclear power (Keepin 1988; Hagen et al. 2001; MIT 2003).

Although the qualitative studies sometimes reference and critique the rationale contained in the existing quantitative estimates of GHGs produced by the nuclear fuel cycle, 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 not directly applicable to the evaluation of GHG emissions that will be associated with the proposed relicensing of IP2 and IP3.

6.2.6 Quantitative

A large number of technical studies, including calculations and estimates of the amount of GHGs emitted by nuclear and other power generation options, are available in the literature. Examples of these studies include Mortimer (1990), Andseta et al. (1998), Spadaro (2000), Storm van Leeuwen and Smith (2005), Fritsche (2006), POST (2006), AEA (2006), Weisser (2006), Fthenakis and Kim (2007), and Dones (2007).

Comparison of the different studies is difficult because the assumptions and components of the lifecycles included within each study vary widely. Examples of differing assumptions that make comparability between the studies difficult include the following:

- the type of energy source that may be used to mine uranium deposits in the future
- the amount of reprocessing of nuclear fuel that will be performed in the future
- the type of energy source and process that might be used to enrich uranium in the future
- different calculations regarding the grade and volume of recoverable uranium deposits in the world
- different estimates regarding the GHG emissions associated with declining grades of recoverable coal, natural gas, and oil deposits
- the release of GHG gases other than CO_2, including the conversion of the masses of these gases into grams of CO_2 equivalents per kilowatt-hour (g C_{eq} /kWh)

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- the technology to be used for future fossil fuel power systems, including cogeneration systems
- the projected capacity factors assumed for the different generation alternatives
- the different types of nuclear reactors used currently and in the projected future (light water reactor, pressurized-water reactor, Canadian deuterium-natural uranium reactor, breeder)

In addition, studies are inconsistent in their application of full lifecycle analyses, including plant construction, decommissioning, and resource extraction (uranium ore, fossil fuel). For instance, Storm van Leeuwen and Smith (2005) present comparisons of GHG emissions from nuclear versus natural gas that incorporate GHG emissions associated with nuclear plant construction and decommissioning in the values used for comparison.

In the case of the proposed IP2 and IP3 relicensing, the relicensing action will not involve additional GHG emissions associated with construction because the facility already exists. In addition, the proposed relicensing action will not involve additional GHG emissions associated with facility decommissioning, because that decommissioning must occur whether the facility is relicensed or not. In many of these studies, the contribution of GHG emissions from facility construction and decommissioning cannot be separated from the other lifecycle GHG emissions that would be associated with IP2 and IP3 relicensing. Therefore, these studies overestimate the GHG emissions attributed to the proposed IP2 and IP3 relicensing action.

In an early study on the subject, Dr. Nigel Mortimer conducted an analysis of the GHG emissions resulting from the nuclear fuel cycle in 1990 (Mortimer 1990). In this study, Mortimer stressed that the GHG implications of the nuclear fuel cycle were substantially related to the ore grade of uranium that must be mined to support nuclear power generation. Using ore grades that were current as of 1990, this study concluded that nuclear power offered a dramatic reduction in GHG emissions over conventional coal-fired power plants over an estimated 35-year lifecycle. The analysis estimated that a nuclear power plant would generate 230,000 tons (209,000 metric tonnes (MT)) of CO_2 over a 35-year life span, or about 3.9 percent of the 5,912,000 tons (5,363,000 MT) that an equivalent coal-fired plant would generate (Mortimer 1990). The study also projected that most of this 230,000 tons (209,000 MT) of CO_2 resulted from the use of a coal-fired plant to perform uranium enrichment by gaseous diffusion, and that using nuclear power and alternative enrichment methods in the future could reduce the amount to 21,000 tons (19,000 MT) (Mortimer 1990).

Mortimer's study went on to demonstrate that the GHG impact of the nuclear fuel cycle would increase as the grade of uranium ore mined dropped, and that the net emissions of CO_2 from the nuclear and coal-fired alternatives would become equal once uranium ore grades reached 0.01-percent uranium oxide. However, Mortimer does not address differences in energy consumption from future extraction and enrichment methods, the potential for higher grade resource discovery, and technology improvements. Based on his cutoff ore grade and projections of ore reserves, Mortimer estimated GHG emissions of nuclear and natural gas generation would occur after a period of 23 years (Mortimer 1990). The analysis also compared GHG emissions associated with the nuclear fuel cycle with other electricity generation and efficiency options, including hydroelectric, wind, tidal power, and new types of insulation and lighting (but not including natural gas). The conclusion was that nuclear power had lower GHG

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emissions compared to coal, but that GHG emissions associated with the nuclear fuel cycle still exceeded those for renewable generation and conservation options (Mortimer 1990).

The Mortimer (1990) study is not presented here to support a definitive conclusion regarding whether nuclear energy produces fewer GHG emissions than other alternatives and similar discussions will not be presented in this draft SEIS for each of the available studies. Instead, the NRC staff presents the Mortimer (1990) study to provide an example of the types of considerations underlying the calculations and arguments presented by the various authors. Almost every existing study has been critiqued, and its assumptions challenged, by later authors. Therefore, no single study has been selected to represent definitive results in this draft SEIS. Instead, the results from a variety of the studies are presented in Tables 6-2, 6-3, and 6-4 to provide a weight-of-evidence argument comparing the relative GHG emissions resulting from the proposed IP2 and IP3 relicensing compared to the potential alternative use of coal-fired plants, natural gas-fired plants, and renewable energy sources.

6.2.7 Summary of Nuclear Greenhouse Gas Emissions Compared to Coal

Because coal is the fuel most commonly used to generate electricity in the United States, and the burning of coal results in the largest emissions of GHGs for any of the likely alternatives to nuclear power, most of the available quantitative studies have focused on comparisons of the relative GHG emissions of nuclear to coal-fired generation. The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle, as compared to an equivalent coal-fired plant, are presented in Table 6-2.

Table 6-2. Nuclear GHG Emissions Compared to Coal

Source	GHG Emission Results
Mortimer 1990	Nuclear—230,000 tons CO_2 Coal—5,912,000 tons CO_2 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 2000	Nuclear—2.5 to 5.7 g C_{eq}/kWh Coal—264 to 357 g C_{eq}/kWh
Storm van Leeuwen and Smith 2005	Authors did not evaluate nuclear versus coal.
Fritsche 2006 (values estimated from graph in Figure 4)	Nuclear—33 g C_{eq}/kWh Coal—950 g C_{eq}/kWh

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POST 2006 (Nuclear calculations from AEA 2006)	Nuclear—5 g C_{eq}/kWh Coal—>1000 g C_{eq}/kWh Note: Decrease of uranium ore grade to 0.03% 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 1250 g Ceq/kWh
Fthenakis and Kim (2007)	Authors did not evaluate nuclear versus coal.
Dones 2007	Author did not evaluate nuclear versus coal.

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6.2.8 Summary of Nuclear Greenhouse Gas Emissions Compared to Natural Gas

The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle, as compared to an equivalent natural gas-fired plant, are presented in Table 6-3.

Table 6-3. Nuclear GHG Emissions Compared to Natural Gas

Source	GHG Emission Results
Mortimer 1990	Author did not evaluate nuclear versus natural gas.
Andseta 1998	Author did not evaluate nuclear versus natural gas.
Spadaro 2000	Nuclear—2.5 to 5.7 g C_{eq}/kWh Natural Gas—120 to 188 g C_{eq}/kWh
Storm van Leeuwen and Smith 2005	Nuclear fuel cycle produces 20 to 33% of the GHG emissions compared to natural gas (at high ore grades). Note: Future nuclear GHG emissions to increase because of declining ore grade.
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% 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%.
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
Fthenakis and Kim (2007)	Authors did not evaluate nuclear versus natural gas.
Dones 2007	Author critiqued methods and assumptions of Storm van Leeuwen and Smith (2005), and concluded that the nuclear fuel cycle produces 15 to 27% of the GHG emissions of natural gas.

6.2.9 Summary of Nuclear Greenhouse Gas Emissions Compared to Renewable Energy Sources

The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle, as compared to equivalent renewable energy sources, are presented in Table 6-4. Calculation of GHG emissions associated with these sources is more difficult than the calculations for nuclear

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energy and fossil fuels because the efficiencies of the different energy sources vary so much by location. For instance, the efficiency of solar and wind energy is highly dependent on the location in which the power generation facility is installed. Similarly, the range of GHG emissions estimates for hydropower varies greatly depending on the type of dam or reservoir involved. Therefore, the GHG emissions estimates for these energy sources have a greater range of variability than the estimates for nuclear and fossil fuel sources.

Table 6-4. Nuclear GHG Emissions Compared to Renewable Energy Sources

Source	GHG Emission Results
Mortimer 1990	Nuclear—230,000 tons CO_2 Hydropower—78,000 tons CO_2 Wind power—54,000 tons CO_2 Tidal power—52,500 tons CO_2 Note: Future GHG emissions from nuclear to increase because of declining ore grade.
Andseta 1998	Author did not evaluate nuclear versus renewable energy sources.
Spadaro 2000	Nuclear—2.5 to 5.7 g C_{eq}/kWh Solar PV—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
Storm van Leeuwen and Smith 2005	Author did not evaluate nuclear versus renewable energy sources.
Fritsche 2006 (values estimated from graph in Figure 4)	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% would raise nuclear to 6.8 g C_{eq}/kWh.
Source	**GHG Emission Results**

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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
Dones 2007	Author did not evaluate nuclear versus renewable energy sources.

6.2.10 Conclusions

Estimating the GHG emissions associated with current nuclear energy sources is challenging because of differing assumptions and noncomparable analyses performed by the various authors. The differences and complexities in these assumptions and analyses increase when using them to project future GHG emissions. However, even with these differences, the NRC staff can draw several conclusions.

First, the studies indicate a consensus that nuclear power currently produces fewer GHG emissions than fossil-fuel-based electrical generation. Based on the literature review, the lifecycle GHG emissions from the complete nuclear fuel cycle currently range from 2.5 to 55 g C_{eq}/kWh. The comparable lifecycle GHG emissions from the current use of coal range from 264 to 1250 g C_{eq}/kWh, and GHG emissions from the current use of natural gas range from 120 to 780 g C_{eq}/kWh. The existing studies also provided estimates of GHG emissions from five renewable energy sources, based on current technology. These estimates included solar-photovoltaic (17 to 125 g C_{eq}/kWh), hydroelectric (1 to 64.6 g C_{eq}/kWh), biomass (8.4 to 99 g C_{eq}/kWh), wind (2.5 to 30 g C_{eq}/kWh), and tidal (25 to 50 g C_{eq}/kWh). The range of these estimates is very wide, but the general conclusion is that the current GHG emissions from the nuclear fuel cycle are of the same order of magnitude as those for these renewable energy sources.

Second, the studies indicate no consensus on future relative GHG emissions from nuclear power and other sources of electricity. There is substantial disagreement among the various authors regarding the GHG emissions associated with declining uranium ore concentrations, future uranium enrichment methods, and other factors, including changes in technology. Similar disagreement exists regarding future GHG emissions associated with coal and natural gas electricity generation. Even the most conservative studies conclude that the nuclear fuel cycle currently produces fewer GHG emissions than fossil-fuel-based sources, and are expected to continue to do so in the near future. The primary difference between the authors is the projected cross-over date (the time at which GHG emissions from the nuclear fuel cycle exceed those of fossil-fuel-based sources) or whether cross-over will actually occur at all.

Considering the current estimates and future uncertainties, it appears that GHG emissions associated with the proposed IP2 and IP3 relicensing action are likely to be lower than those associated with fossil-fuel-based energy sources. The NRC staff bases this conclusion on the

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following rationale:

(1) The current estimates of GHG emissions from the nuclear fuel cycle are far below those for fossil-fuel-based energy sources.

(2) IP2 and IP3 license renewal will involve continued 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).

(3) Few studies predict that nuclear fuel cycle emissions will exceed those of fossil fuels within a timeframe that includes the IP2 and IP3 periods of extended operation. Several studies suggest that future extraction and enrichment methods, the potential for higher grade resource discovery, and technology improvements could extend this timeframe.

With respect to comparison of GHG emissions between the proposed IP2 and IP3 license renewal action 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, and constructing facilities in both areas. Currently, the GHG emissions associated with the nuclear fuel cycle and renewable energy sources are within the same range. 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 IP2 and IP3 at some point during the period of extended operation.

6.3 References

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy,* Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 54. Code of Federal Regulations, Title 10, *Energy,* Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."

10 CFR Part 63. Code of Federal Regulations, Title 10, *Energy,* Part 63, "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada."

40 CFR Part 191. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste."

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7.0 ENVIRONMENTAL IMPACTS OF DECOMMISSIONING

Environmental impacts from the activities associated with the decommissioning of any reactor before or at the end of an initial or renewed license are evaluated in NUREG-0586, Supplement 1, "Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors" (NRC 2002). The U.S. Nuclear Regulatory Commission (NRC) staff's evaluation of the environmental impacts of decommissioning presented in NUREG-0586, Supplement 1, identifies a range of impacts for each environmental issue.

The incremental environmental impacts associated with decommissioning activities resulting from continued plant operation during the renewal term are discussed in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999).[1] The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues were then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, 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 collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(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.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1; therefore, additional plant-specific review of these issues is required. There are no Category 2 issues related to decommissioning.

7.1 Decommissioning

Category 1 issues in Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51) that are applicable to IP2 and IP3 decommissioning following the renewal term are listed in Table 7-1. Entergy Nuclear Operations, Inc. (Entergy), stated in the IP2 and IP3 environmental report (ER) (Entergy 2007) that it is not aware of any new and

[1] The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the GEIS include the GEIS and its Addendum 1.

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significant information regarding the environmental impacts of IP2 and IP3 license renewal, though it did identify leaks from spent fuel pools as a potential new issue. The NRC staff addressed this issue The NRC staff addressed this issue in Sections 2.2.7, 4.3, and 4.5 of this draft supplemental environmental impact statement (SEIS). In Section 4.5, the NRC staff concludes that the abnormal liquid releases (leaks) discussed by Entergy in its ER, while new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20 and are not considered to have a significant impact on plant workers, the public, or the environment (i.e., while the information related to spent fuel pool leakage is new, it is not significant).

The NRC staff has not identified any information during its independent review of the IP2 and IP3 ER (Entergy 2007), the site visit, the scoping process, or its evaluation of other available information that is both new and significant. Therefore, the NRC staff concludes that there are no impacts related to the Category 1 issues applicable to the decommissioning of IP2 and IP3 beyond those discussed in the GEIS. For all of these issues, the NRC staff concluded in the GEIS that the impacts are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 7-1. Category 1 Issues Applicable to the Decommissioning of IP2 and IP3 Following the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
DECOMMISSIONING	
Radiation doses	7.3.1
Waste management	7.3.2
Air quality	7.3.3
Water quality	7.3.4
Ecological resources	7.3.5
Socioeconomic impacts	7.3.7

A brief description of the NRC staff's review and the GEIS conclusions, as codified in Table B-1, 10 CFR Part 51, for each of the issues follows:

- Radiation doses. Based on information in the GEIS, the Commission found the following:

  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.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no radiation dose impacts associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

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- Waste management. Based on information in the GEIS, the Commission found the following:

  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.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts from solid waste associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Air quality. Based on information in the GEIS, the Commission found the following

  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.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts on air quality associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Water quality. Based on information in the GEIS, the Commission found the following:

  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.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts on water quality associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

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- Ecological resources. Based on information in the GEIS, the Commission found the following:

  Decommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts on ecological resources associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Socioeconomic Impacts. Based on information in the GEIS, the Commission found the following:

  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.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no socioeconomic impacts associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

7.2 References

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy,* Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

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8.0 ENVIRONMENTAL IMPACTS OF ALTERNATIVES TO LICENSE RENEWAL

This chapter examines the potential environmental impacts associated with (1) the closed-cycle cooling system alternatives to replace the Indian Point Nuclear Generating Unit No. 2 (IP2) and Unit No. 3 (IP3) existing once-through cooling-water systems, (2) denying the renewal of both operating licenses for IP2 and IP3 (i.e., the no-action alternative), (3) replacing the electric generation capacity of both units with alternative electric-generation sources, (4) importing electric power from other sources to replace power generated by IP2 and IP3, and (5) combinations of generation and conservation measures to replace power generated by IP2 and/or IP3. In addition, this chapter discusses other alternatives that were deemed unsuitable for replacement of power generated collectively by IP2 and IP3.

The U.S. Nuclear Regulatory Commission (NRC) staff considered alternatives to the existing IP2 and IP3 cooling-water systems because the New York State Department of Environmental Conservation (NYSDEC) identified closed-cycle cooling (e.g., cooling towers) as the best technology available (BTA) to reduce fish mortality in the draft New York State Pollutant Discharge Elimination System (SPDES) discharge permit (NYSDEC 2003a). These alternatives are described in Section 8.1 of this draft supplemental environmental impact statement (SEIS). IP2 and IP3 have been operating under timely renewal provisions of the New York SPDES permit process since 1992. In 2003, NYSDEC issued a draft SPDES permit for public comment, including the BTA determination. The requirements, limits, and conditions of the draft SPDES permit had not been finalized at the time the NRC staff performed the assessment presented in this draft SEIS,.

The environmental impacts of alternatives are evaluated using the NRC's three-level standard of significance—SMALL, MODERATE, or LARGE—developed based on the Council on Environmental Quality (CEQ) guidelines and set forth in the footnotes to Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51). The following definitions are used for each category:

> 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 impact categories evaluated in this chapter are the same as those used in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999)[1] with the additional impact

[1] The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the GEIS include the GEIS and its Addendum 1.

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categories of environmental justice and transportation.

8.1 Alternatives to the Existing IP2 and IP3 Cooling-Water System

IP2 and IP3 currently use once-through cooling-water systems that withdraw water from and discharge water to the Hudson River as described in Section 2.1.3 of this draft SEIS. The circulating water systems for IP2 and IP3 include two intake structures, each containing seven pumps. The normal design flow rate of 3,180,000 liters per minute (lpm) (840,000 gallons per minute (gpm)) for each unit is achieved using dual-speed pumps for IP2 and variable-speed pumps for IP3.

Warm discharge water from IP2 and IP3 flows from the condensers through six pipes that are 2.4 meters (m) (96 inches (in.)) in diameter and exits beneath the water surface into a discharge canal 12 m (40 feet (ft)) wide. Water flows from the discharge canal to the Hudson River through an outfall structure located south of IP3 at a discharge velocity of about 3.7 meters per second (mps) (10 feet per second (fps)). The design of the outfall is intended to reduce the thermal impact the warm water has on the river. An assessment of the impacts of the current cooling-water system on the environment is presented in Section 4.1 of this draft SEIS.

Surface water withdrawals and discharges at IP2 and IP3 are regulated under the New York SPDES permit program. In 1975, the U.S. Environmental Protection Agency (EPA) issued National Pollutant Discharge Elimination System (NPDES) permits for the facility. Subsequently, the NYSDEC issued an SPDES permit for the facility in 1987. In 1992, a timely renewal application was filed with the NYSDEC, and terms of the 1992 SPDES have been continued under provisions of the NY State Administrative Procedure Act. Petitioners commenced proceedings in 2002 to mandate that the NYSDEC act on the SPDES permit renewal application. On April 8, 2003, the NYSDEC proposed to modify the SPDES permit to require that IP2 and IP3 reduce the impacts to aquatic organisms caused by the once-through cooling systems and that Entergy Nuclear Operations, Inc. (Entergy), complete a water quality review. A draft SPDES permit identifying closed-cycle cooling as the BTA was issued on November 14, 2003 (NYSDEC 2003a).

The draft SPDES permit requires that immediate and long-term steps be taken to reduce the adverse impacts on the Hudson River estuary once the permit is issued (NYSDEC 2003a). The short-term steps include mandatory outage periods, reduced intake during certain times, continued operation of fish-impingement mitigation measures, the payment of $25 million to a Hudson River Estuary Restoration Fund, and various studies. In the long term, IP2 and IP3 will have to implement the BTA to minimize environmental impacts to the aquatic ecology. Should the BTA determination in the draft SPDES permit go into effect, final implementation of the BTA is subject to NRC's approval only insofar as the NRC oversees the plant's safety performance and ability to cool itself. Based on NYSDEC's fact sheet addressing the draft SPDES permit, NYSDEC will not require closed cycle cooling if IP2 and IP3 do not receive renewed licenses from the NRC (NYSDEC 2003c).

Specifically, the draft SPDES permit states the following:

> Within six months of the effective date of this permit, the permitee must submit to the NYSDEC…its schedule for seeking and obtaining, during its permit term, all necessary approvals from the NRC, Federal Energy Regulatory Commission

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(FERC), and other government agencies to enable construction and operation of closed-cycle cooling at Indian Point.

NYSDEC (2003a) has also indicated that an alternative technology or technologies may be proposed for IP2 and IP3 within 1 year of the permit's effective date. These technologies must be able to minimize the adverse environmental impacts to a level equivalent to that achieved by a closed-cycle cooling system at IP2 and IP3 (NYSDEC 2003b).

The NYSDEC identified construction and operation of a closed-cycle cooling system at IP2 and IP3 as its preferred alternative to meet current national performance standards for impingement and entrainment losses. Entergy indicates that Entergy or its predecessors have proposed and NYSDEC has rejected the following alternative cooling technologies as described in the IP2 and IP3 ER (Entergy 2007). As a result, these options are not discussed further in this draft SEIS.

- Evaporative ponds, spray ponds, or cooling canals all require significantly more land area than exists at the site.
- Dry cooling towers, which rely totally on sensible heat transfer, lack the efficiency of wet or hybrid towers using evaporative cooling, and thus require a far greater surface area than is available at the site. Additionally, because of their lower efficiency, dry towers are not capable of supporting condenser temperatures necessary to be compatible with IP2 or IP3 turbine design and, therefore, are not a feasible technology.
- Natural draft cooling towers, while potentially feasible, would be 137 to 152 m (450 to 500 ft) above ground level with significant adverse aesthetic impacts in an important viewshed corridor. This option also would raise plume-related and sound effects concerns. In the original EPA permitting proceeding, New York State opposed natural draft cooling towers on aesthetic grounds.
- Single-stage mechanical-draft wet cooling towers for a number of reasons including, but not limited to, the dense water vapor plumes that may compromise station operations (including visual signaling) and equipment over time, and result in increased noise (Enercon 2003).

The EPA has concluded that, in some circumstances, retrofitting a plant to a closed-cycle cooling system lacks demonstrated feasibility or economic practicality (EPA 2004). In addition, Entergy asserts that retrofitting facilities the size and configuration of IP2 and IP3 with a closed-cycle cooling system is neither tried nor proven (Entergy 2007). Entergy also considers mitigation measures currently implemented to protect aquatic wildlife as part of the once-through cooling system to be adequate in terms of minimizing impacts from current operations and operations during the license renewal period (Entergy 2007).

Entergy expressed a number of concerns regarding financial or technical issues related to a closed-cycle cooling retrofit (Entergy 2007), including high cost, a lengthy forced outage, and lost power output due to parasitic losses from new cooling system components. In the Hudson River Utilities FEIS, NYSDEC indicated that the previous owners' closed-cycle cooling cost estimates were likely generally reasonable (NYSDEC 2003d), while EPA indicated that costs may have been somewhat inflated (EPA 2004). EPA also indicated some uncertainty with regard to outage duration for the plant retrofit.

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Entergy notes that replacement power during the outage may carry negative air quality impacts, and that the outage may have negative impacts on electric-system reliability and market pricing.

Finally, Entergy indicates that closed-cycle cooling would result in a loss of generating capacity due to lowered thermal efficiency and parasitic loads related to cooling system pumps and auxiliary systems (an average annual loss of 26 MW(e), per unit) because of power demands of the closed-cycle system (Entergy 2007).

In the following chapter, the NRC staff will evaluate the environmental impacts associated with installing a closed-cycle cooling system at Indian Point, as well as the environmental impacts associated with a potentially-equivalent combination of plant modifications and restoration activities. Regardless of the NRC staff's findings, the NRC does not have the regulatory authority to implement the requirements of the Clean Water Act , and it is not up to the NRC staff to judge the validity of Entergy's or others' claims in the ongoing NYSDEC SPDES permit process. The NRC staff, however, notes that both NYSDEC (2003b) and EPA (2004) indicated that estimates for cooling conversion by the previous owners of IP2 and IP3 overestimated a variety of costs and selected a more-expensive technology than was necessary. Further, EPA (2004) indicated that Entergy's outage duration was likely exaggerated.

In 2004, EPA issued regulations for reducing impingement and entrainment losses at existing electricity-generating facilities (EPA 2004). These regulations, know as the Phase II rule, established standards for compliance with the requirements of Section 316(b) of the Clean Water Act (CWA), which calls for intake structures to reflect the BTA for minimizing adverse environmental impact. The EPA's Phase II rule established two compliance alternatives that reduce impingement mortality by 80 to 95 percent of baseline and reduce organism entrainment by 60 to 90 percent of baseline (EPA 2004). These regulations supported the requirements of the draft New York SPDES permit's requirement that immediate and long-term steps be taken to minimize adverse impacts on the Hudson River estuary.

The EPA's rules concerning Phase II of Section 316(b) of the CWA were struck down by the U.S. Court of Appeals in the Second Circuit in January, 2007. The Court also mandated the conduct of a cost-benefit analysis under Section 316(b) of the CWA. That decision is currently on appeal before the U.S. Supreme Court. Specifically, the EPA suspended 40 CFR Part 122.2(r)(1)(ii) and (5) and Subpart J, "Requirements Applicable to Cooling Water Intake Structures for Phase II Existing Facilities Under Section 316(b) of the Act," of 40 CFR Part 125, "Criteria and Standards for the National Pollutant Discharge Elimination System," with the exception of 40 CFR 125.90(b) (EPA 2007). However, the issued SPDES permit remains in effect, pending the conclusion of related administrative and legal proceedings.

8.1.1 Closed-Cycle Cooling Alternative

As indicated in Section 8.1, NYSDEC identified closed-cycle cooling as a BTA in its 2003 draft SPDES permit (NYSDEC 2003a, 2003c). Entergy's preferred close-cycle alternative consists of two hybrid mechanical-draft cooling towers (Enercon 2003, Entergy 2007). IP2 and IP3 would each utilize one cooling tower. Entergy rejected single-stage mechanical draft cooling towers, indicating that the dense water vapor plumes from the towers may compromise station operations (including visual signaling) and equipment over time, and single-stage towers may result in increased noise (Enercon 2003).

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Entergy asserts that a hybrid mechanical-draft cooling tower system, also referred to as a "wet/dry" or "plume-abated" mechanical-draft cooling tower, addresses some of the shortcomings of the cooling system types described in Section 8.1 (Entergy 2007). In the ER, Entergy indicates that hybrid towers are "appreciably more expensive" than single-stage towers (2007).

A hybrid tower consists of a standard efficiency wet tower segment combined with a dry heat exchanger section above it. The dry section eliminates visible plumes in the majority of atmospheric conditions. After the plume leaves the lower "wet" section of the tower, it travels upward through a "dry" section where heated, relatively dry air is mixed with the plume in the proportions required to achieve a nonvisible plume. Because of the "dry" section, which is on top of the "wet" section, hybrid towers are slightly taller than comparable wet towers and require a larger footprint (Entergy 2007). Hybrid towers are also appreciably more expensive, both in initial costs and in ongoing operating and maintenance costs (Entergy 2007). A potential exists for increased noise from additional fans in the dry section, although Entergy indicates that sound effects can be attenuated (Entergy 2007).

Portions of the site where Entergy could construct cooling towers are heavily forested, with rocky terrain and some steep slopes. Entergy indicates that these areas can be more environmentally sensitive and costly to build on.

The NRC staff has previously assessed closed cycle cooling with a hybrid cooling tower in the license renewal SEIS for Oyster Creek Nuclear Generating Station (OCNGS) (NRC 2006). The NRC staff finds that a hybrid cooling tower system is a reasonable design for the purpose of evaluating potential environmental impacts in a NEPA document. However, the NRC staff does not intend for this analysis to prejudice potential requirements imposed by NYSDEC or other authorities.

Should hybrid towers prove prohibitively expensive (as determined by other, non-NRC authorities), the NRC staff notes that single-stage mechanical draft towers will produce similar decreases in impacts to aquatic life and may result in less land-clearing or blasting debris than the hybrid cooling tower option. Additionally, single-stage towers will be shorter, though plumes in cool or highly-saturated atmospheric conditions will impose slightly greater aesthetic impacts as well as creating greater deposition of ice or dissolved solids near the towers than the circular, hybrid towers proposed by Entergy would cause.

8.1.1.1 Description of the Closed-Cycle Cooling Alternative

As described in the ER (Entergy 2007), new hybrid cooling towers would be large, approximately 170 m (560 ft) in diameter and 46 to 50 m (150 to 165 ft) high. To provide construction access for tower erection and clearance for air intake, the excavation diameter for each tower would be approximately 700 ft. The locations for the IP2 and IP3 towers are expected to be approximately 305 m (1000 ft) north of the IP2 reactor and approximately 305 m (1000 ft) south of the IP3 reactor, respectively. A detailed description of a round hybrid cooling tower conceptual design is presented in the 2003 cooling tower evaluation (Enercon 2003). Crews excavating areas for the cooling tower basins and associated piping may need to blast substantial amounts of rock during the construction process.

As noted in Section 8.1, the closed-cycle cooling alternative would introduce parasitic losses from additional pumps and other equipment. The new circulating pumps would likely be housed in a new pumphouse located along the discharge canal (Enercon 2003). The new, enclosed

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pumphouse would supply circulating water to the new towers via two concrete-lined steel pipes 3 m (10 ft) in diameter. Flow from the cooling tower basin to the condenser is expected via two pipes 3.7 m (12 ft) in diameter (Enercon 2003).

Enercon also reported that two dedicated substations would likely supply electricity to the closed-cycle cooling system from the 138-kilovolt (kV) offsite switchyard. The substation transformers, switch gear, and system controls for each tower and pumphouse would be housed in prefabricated metal buildings (Enercon 2003).

8.1.1.2 Environmental Impacts of the Closed-Cycle Cooling Alternative

In this section, the NRC staff addresses the impacts that would occur if Entergy constructs and operates the closed-cycle cooling system described in Section 8.1.1.1. The NRC staff summarizes anticipated impacts of the closed-cycle cooling alternative summarized in Table 8-1. In the areas of land use, terrestrial ecology, waste, and aesthetics, the environmental impacts of constructing and operating this closed-cycle cooling system would be greater than the impacts associated with the existing once-through cooling system, primarily due to construction-stage impacts. The closed-cycle cooling alternative significantly reduces impacts to aquatic ecology, including impacts from entrainment, impingement, and heat shock. Impacts to aquatic threatened and endangered species are also likely to decline. In the following sections, the NRC staff presents the potential environmental impacts of installing and operating a closed-cycle cooling alternative at Indian Point. The NRC staff addresses impacts for each resource area.

- **Land Use**

Construction of hybrid mechanical-draft cooling towers would entail significant clearing and excavation of the currently timbered areas within the IP2 and IP3 exclusion area. Each cooling tower requires an excavated area of approximately 3.6 hectares (ha) (9 acres (ac)). Ultimately, approximately 16 ha (40 ac), most of which is presently wooded (though previously disturbed; ENN 2007), would need to be cleared for the two cooling towers, access roads, and support facilities (Enercon 2003). The towers would be located within the property exclusion area boundary adjacent to existing facilities as described in Section 8.1.1.1.

Entergy indicates that roughly 305 m (1000 ft) of river bank would be clear-cut and excavated to allow for the installation of the four large-diameter water pipes (two 3-m-diameter supply pipes and two 3.7-m-diameter pipes to each condenser) required for each tower (Entergy 2007). In addition, Enercon reports that the base of each tower would be constructed on bedrock at an elevation of about 9.1 m (30 ft) above mean sea level. This would entail the removal of approximately 2 million cubic yards (cy) (1.5 million cubic meters (m^3)) of material, primarily rock and dirt, using traditional excavation methods as well as a significant amount of blasting (Entergy 2007). Disposal of 2 million cy (1.5 million m^3) of material from the excavations for the cooling towers may create offsite land use impacts. Excavated material also may be recycled or reused, which would reduce these impacts.

Entergy's proposed IP3 cooling tower would be located in the permanent right-of-way (ROW) easement granted to the Algonquin Gas Transmission Company (AGTC) for constructing, maintaining, and operating the three natural gas pipelines that traverse the IP2 and IP3 site (Entergy 2007). These pipelines transport natural gas under the Hudson River, across the IP2 and IP3 site, and exit the site between Bleakley Avenue and the Buchanan substation (see

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Figure 2-3 in Chapter 2 of this SEIS for a graphical representation).

Entergy indicates that ROW easement agreement calls for AGTC to relocate the pipelines at Entergy's request. The Federal Energy Regulatory Commission (FERC) would first have to review and approve any such action. Entergy must also provide a suitable location for the pipeline on its land or land that it has acquired (Entergy 2007). Entergy indicates that pipeline relocation may require blasting and could also require Entergy to purchase additional land adjacent to the IP2 and IP3 site if onsite areas aren't suitable for the pipeline (Entergy 2007). Feasibility studies and other regulatory approvals may also be necessary (Enercon 2003).

The IP2 and IP3 site is within New York's Coastal Zone. As indicated in Chapter 2, the IP2 and IP3 site is located adjacent to a Significant Coastal Fish and Wildlife Habitat. Construction activities, such as grading, excavating, and filling, would require a coastal erosion management permit. Permitting restrictions would influence the construction of the cooling towers but they would not likely prevent Entergy from building the towers.

Excavation for the cooling towers would cut into the side of the hills east of IP2 and IP3, resulting in the removal of approximately 2 million cy of material, including significant rock as well as dirt (Entergy 2007).

The NRC staff concludes that construction activities associated with cooling tower installation at IP2 and IP3 would result in SMALL to LARGE land use impacts, depending largely on how much material Entergy is unable to reuse or recycle, and where Entergy disposes of excavated material that cannot be reused or recycled.

- **Ecology**

Aquatic ecology. Land-clearing and construction activities can cause short-term, localized impacts on streams and rivers from increased site runoff. These impacts are generally mitigated through the use of erosion and sediment controls. Because of the size of the construction area needed for the cooling towers at the IP2 and IP3 site, such measures would be necessary to limit erosion and sediment deposition in the Hudson River. Construction impacts, however, would be relatively short-lived, and would be offset to some degree by reduced water consumption during prolonged outages at IP2 and IP3 when Entergy or its contractors would connect the closed-cycle cooling system to the units.

Following construction, the closed-cycle cooling alternative will significantly reduce operational impacts compared to the current once-through cooling system. During the summer months, when water use is at its highest, service and cooling tower makeup water would be withdrawn at a rate of approximately 250,000 to 314,000 lpm (66,000 to 83,000 gpm) for the combined needs of IP2 and IP3. This would be a 93-to-95-percent reduction in water use compared to the existing IP2 and IP3 once-through systems, which have a normal design flow rate of 3,200,000 lpm (840,000 gpm) for each unit. Without modifications to the intake screening technologies, the NRC staff assumes that the reduction in water intake results in an equivalent reduction in entrainment and impingement. The staff concludes that this significant reduction in water demand would likely result in a similarly significant reduction in entrainment- and impingement-related losses compared to the losses created by the current once-through cooling system.

New circulating-water intake pumps would likely continue to utilize the Ristroph traveling screens and fish-return system currently in operation (Entergy 2007), as well as the current intake bay area. The greatest impact of the closed-cycle system would be a reduction in

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entrainment and impingement of aquatic species. As described in Section 4.1.3.3 of this draft SEIS, the NRC staff has concluded that the once-through cooling system has a direct impact on some representative important species (RIS), which ranges from SMALL to LARGE depending on the species affected. The reduction in flow may also reduce impingement or entrainment of RIS to which the NRC staff could not assign a specific impact level, including blue crab (*Callinectes sapidus*), the endangered shortnose sturgeon (*Acipenser brevirostrum)*, and macroinvertebrates, such as small clams and mussels (bivalves), snails, worms, crustaceans, and aquatic insects. In Section 4.6.2, the NRC staff had indicated that the impacts to the shortnose sturgeon could range from SMALL to LARGE, because of uncertainty due to the lack of current sampling data.

Under a closed-cycle cooling system, most discharged blowdown water is unheated. Because the closed-cycle cooling system discharges a smaller volume of water, and because the water is cooler than in a once-through system, the extent of thermal impacts would be significantly reduced. Thus, the effects of thermal shock also decline. However, the discharge water may be higher in salinity and may contain higher concentrations of biocides, minerals, trace metals, or other chemicals or constituents. To maintain compliance with discharge permits, the water may need to be treated.

Overall, operation of the closed-cycle cooling alternative would produce substantially fewer impacts to the aquatic environment relative to those caused by the existing once-through system. The NRC staff concludes that the aquatic ecological impacts (including those to threatened and endangered species) from the construction and operation of the hybrid mechanical-draft closed-cycle cooling alternative for IP2 and IP3 would be SMALL.

<u>Terrestrial ecology</u>. Construction of the closed-cycle cooling alternative would entail clear-cutting of onsite trees and excavation of areas for the two cooling towers as described in the Land Use section. These activities would destroy fragments of onsite eastern hardwood forest habitat (NYSDEC 2007; NYSDEC 2008a). Effects of removing these habitats could include localized reductions in productivity or relocations of some species.

Operation of the cooling towers also could have adverse localized impacts on terrestrial ecology. The cooling towers would be about 46 to 50 m (150 to 165 ft) tall and would produce a visible plume as well as minimal ground fog (Enercon 2003). The potential physical impacts from a cooling tower plume include icing and fogging of surrounding vegetation during winter conditions. Icing can damage trees and other vegetation near the cooling towers. The salt content of the entrained moisture (drift) also has the potential to damage vegetation, depending on concentrations (Enercon 2003). Enercon reported, however, that the predicted deposition rates for the towers are on the order of the natural ambient salt deposition rate (Enercon 2003). The hybrid cooling towers evaluated in this section have a drift rate of 0.001 percent (Enercon 2003). This amounts to 2.6 lpm (0.7 gpm (0.00001 x 70,000 gpm of water)) drift for both towers. The amount and effects of drift would vary depending on a number of factors, including the concentration of salt in the droplets, the size of the droplets, the number of droplets per unit of surface area, the species of plant affected, and the frequency of local precipitation.

Actual measurements of drift deposition have been collected at only a few nuclear plants. These measurements indicate that, beyond about 1.5 kilometer (km) (about 1 mile (mi)) from nuclear plant cooling towers, salt deposition is generally near natural levels (NRC 1996). The NRC staff reported in the GEIS that the salt-drift rate estimated to cause acute injury to the

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eastern/Canadian hemlock (a particularly sensitive species) is in excess of 940 kilograms (kg) per square kilometer (km^2) (8.4 pounds per acre) per week (NRC 1996), well above the anticipated deposition rates from the IP2 and IP3 cooling towers.

The NRC staff does not expect bird collisions with cooling towers to be a significant issue. The NRC staff found in the GEIS that impacts from collisions would be small at all plants with existing cooling towers (NRC 1996).

Section 4.6.2 of this draft SEIS discusses the effects of license renewal on threatened or endangered terrestrial species. The section identifies the endangered Indiana bat (*Myotis sodalis*), the threatened bog turtle (*Clemmys muhlenbergii*), and the New England cottontail (*Sylvilagus transitionalis*), a candidate species, as being potentially affected. However, because of both the site-specific environment and the lack of evidence of the species existing at the facility, potential impacts to these threatened or endangered species are considered SMALL.

While the effects of this alternative—including onsite land clearing and introduction of cooling tower drift—are greater than the effects of the continued operation of the once-through cooling system and are likely to be noticeable, they are not so great that they will have a destabilizing effect on terrestrial resources in the vicinity of IP2 and IP3. The NRC staff concludes that the overall effect on terrestrial ecology would be SMALL to MODERATE.

- **Water Use and Quality**

During construction of the alternative closed-cycle cooling systems at IP2 and IP3, changes in water usage would likely be negligible. Increases may be seen in potable water demand for construction workers and, if concrete is mixed on site, there would be additional demands. However, these water needs would be short lived and would be at least partially offset by a reduction in water use while IP2 and IP3 are in outages to install the closed-cycle cooling system. For the term of construction, the additional water demands would need to be met by the Village of Buchanan, which supplies water to the site. The Village of Buchanan purchases public drinking water from surface water supplies.

The NYSDEC requires a construction general permit for storm water discharges from a project such as construction of the hybrid cooling towers. In addition, the NYSDEC will require a stormwater pollution prevention plan describing the use of silt fencing and other erosion-control management practices that will be used to minimize impacts on surface water quality. The construction project could also affect ground water as a result of dewatering excavations.

Evaporation losses (23,000 to 46,000 lpm (6,000 to 12,000 gpm)) from the cooling towers will have a negligible impact on water flow past the site. The estimated flow 150 m (500 ft) off the shoreline is about 34 million lpm (9 million gpm) in a 150-to-180-m (500-to-600-ft)-wide section (Entergy 2007). Therefore, the evaporation loss would be approximately 0.1 percent of the river flow. Further, the estuarine Hudson River is at sea level, and thus the river's water level would not be affected by the cooling towers' consumptive water use.

To compensate for evaporative and discharge losses, makeup water from the Hudson River would be treated to remove silt, suspended solids, biological material, and debris. Makeup water may also need lime softening, a water treatment process that produces a waste sludge that requires disposal. Biocides, such as hypochlorite, are often added to cooling water to diminish the affects of the biofouling organisms (Entergy 2007). Other chemicals, such as acids, dispersants, scale inhibitors, foam suppressants, and dechlorinators may also be needed

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for water treatment (NRC 1979).

To manage the chemicals and elevated concentrations of dissolved solids in the discharge water, treatment would likely be necessary in accordance with the IP2 and IP3 site SPDES permit. The use of biocides or any other chemicals would likely require discharge treatment and additional monitoring.

The IP2 and IP3 site does not utilize ground water for cooling operations, service water, or potable water. As such, the continued operation of the site is not expected to affect local ground water supplies (EPA 2008a). Localized dewatering of ground water from excavations may be necessary during construction operations, but because this ground water is not used by Entergy or entities off site, and because the ground water discharges to the Hudson River after exiting the IP2 and IP3 site, construction is not likely to affect either ground water quality or ground water use.

Proper controls of runoff and treatment of other site discharges will not result in significant impacts on the surface water (Hudson River) and evaporation losses are very small. Also, ground water impacts from construction and operation of the cooling towers are expected to be minor. Therefore, the NRC staff concludes that overall impacts to water resources and water quality from the closed-cycle cooling alternative would be SMALL.

- **Air Quality**

The IP2 and IP3 site is located within the New Jersey-New York-Connecticut Interstate Air Quality Control Region (40 CFR 81.13, "New Jersey-New York-Connecticut Interstate Air Quality Control Region"). The air quality nonattainment issues associated with the portions of these States located within a 50-mi radius are related to ozone (8-hour standard) and particulate matter less than 2.5 microns (µm) in diameter ($PM_{2.5}$). The entire States of New Jersey and Connecticut are designated nonattainment areas for ozone (8-hour standard). Several counties in Central and Southeastern New York within a 50-mi radius are also in nonattainment status for the 8-hour ozone standard (EPA 2008b). Air quality would be affected by three different factors: replacement power during construction-related outages, construction activities and vehicles (including worker transportation), and cooling tower operations.

Entergy contractors indicate that prolonged outages of IP2 and IP3, such as would be required to install cooling towers (TRC 2002) would require replacement power from existing generating facilities within the New York City metropolitan area. They assert that replacement of IP2 and IP3 energy output during cooling tower installation would result in substantial increases in regulated air pollutants. To the extent that coal- and natural-gas-fired facilities replace IP2 and IP3 output, the NRC staff finds that some air quality effects would occur. The NRC staff finds that these effects would cease when IP2 and IP3 return to service, with the exception of any output lost to new parasitic loads from the closed-cycle cooling system.

Air quality at or near IP2 and IP3 during the construction of the IP2 and IP3 cooling towers would be affected mostly by exhaust emissions from internal combustion engines. These emissions would include carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compounds (VOCs), sulfur oxides (SO_x), carbon dioxide (CO_2), and particulate matter 10 µm or less in diameter (PM_{10}) from operation of gasoline- and diesel-powered heavy-duty construction equipment, delivery vehicles, and workers' personal vehicles (these vehicles would also produce or contribute to production of $PM_{2.5}$). The amount of pollutants emitted from

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construction vehicles and equipment and construction worker traffic would likely be small compared with total vehicular emissions in the region.

As noted in Section 3.3 of the GEIS, a conformity analysis is required for each pollutant when the total direct and indirect emissions caused by a proposed Federal action would exceed established threshold emission levels in a nonattainment area. In the GEIS, the NRC determined that a major refurbishment activity may increase the facility workforce by up to 2300 construction, refurbishment, and refueling personnel during a significant refurbishment outage period. The construction of two new cooling towers at IP2 and IP3 could approximate such conditions; however, Entergy estimates that the construction activities would require an average workforce of 300 additional workers with a maximum of about 600 workers (Enercon 2003). Because IP2 and IP3 are in a nonattainment area for ozone, and emissions from vehicles of the additional workforce may exceed the ozone air quality thresholds, a conformity analysis would be required before construction.

Fugitive dust, a contributor to PM_{10}, would be generated from site clearing and construction traffic, blasting, and excavation. Given the size of the disturbed area that would be involved (about 16 ha (40 ac)), and assuming that dust management practices would be applied (e.g., watering, silt fences, covering soil piles, revegetation), the fugitive dust impacts generated during construction should be minor. Furthermore, the amount of road dust generated by the vehicles traveling to and from the site transporting workers or hauling rock and dirt would contribute to PM_{10} concentrations. Construction stage impacts, though significant, would be relatively short lived.

Operation stage impacts would, overall, be minor. As previously discussed, the cooling towers would emit tower drift consisting of water, salt, and suspended solids. These emissions would be considered PM10, and some portion may include PM2.5. Because IP2 and IP3 are located in a nonattainment area for PM2.5, a conformity analysis for the cooling towers would be necessary and may result in additional restrictions on emissions, additional compensatory measures, or further control of drift from the towers. At a minimum, drift eliminators would likely be required to keep these emissions to a low level.

Because air quality effects during construction would be controlled by site practices and compensatory measures required to maintain compliance with the Clean Air Act (CAA) (should a conformity analysis show the need to take other action), because replacement power would be required to also comply with CAA requirements (and it would be short lived), and air quality effects during operations would be minor, the NRC staff concludes that overall impact to air quality is likely SMALL.

- **Waste**

Construction of the closed-cycle cooling alternative at IP2 and IP3 would generate some construction debris and an estimated 2 million cy (1.5 million m^3) of rock and soil (Entergy 2007). This material may be affected by onsite spills or other activities. Depending on the characteristics of the material, it may be possible to reuse or recycle it. If the material cannot be reused or recycled, it will have to be properly managed as a waste. Whether reused, recycled, or disposed of, the material will have to be transported off site. If disposed of, the waste will require additional offsite land use.

Some solid wastes may be generated by water treatment processes. Any such waste would be

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treated and/or disposed of in accordance with State solid waste regulations. During operation, Entergy will have to maintain release of solids and chemicals to the blowdown water and, subsequently, to the discharge canal and the Hudson River in accordance with IP2 and IP3 SPDES permits. Other solid wastes from tower operation and maintenance (including sludge from the tower basins) would be managed and disposed of in accordance with applicable State regulations at approved offsite facilities.

Based primarily on the large volume of rock and soil that would require offsite transportation and may require disposal, the NRC staff concludes that waste-related impacts associated with the closed-cycle cooling alternative at IP2 and IP3 could range from SMALL to LARGE, depending on whether material can be reused or recycled.

- **Human Health**

Human health impacts for an operating nuclear power plant are identified in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. Potential impacts on human health from the operation of closed-cycle cooling towers at nuclear power plants are evaluated in Section 4.3.6 of the GEIS.

During construction activities there would be risk to workers from typical industrial incidents and accidents. Accidental injuries are not uncommon in the construction industry and accidents resulting in fatalities do occur. However, the occurrence of such events is mitigated by the use of proper industrial hygiene practices, complying with worker safety requirements, and training. Occupational and public health impacts during construction are expected to be controlled by continued application of accepted industrial hygiene protocols, occupational health and safety controls, and radiation protection practices.

Hybrid cooling towers at IP2 and IP3 would likely be equipped with sound attenuators (Entergy 2007). The topography of the area would provide additional attenuation of the noise levels. An analysis of potential offsite noise levels resulting from both cooling towers operating continuously indicated that the increase in noise levels at sensitive receptor sites would be 1 decibel or less, a level most likely not noticeable by the residents of the Village of Buchanan (Enercon 2003).

The GEIS evaluation of health effects from plants with cooling towers focuses on the threat to workers from microbiological organisms whose presence might be enhanced by the thermal conditions found in cooling towers. The microbiological organisms of concern are freshwater organisms that are present at nuclear plants that use cooling ponds, lakes, or canals and that discharge to small rivers (NRC 1996). Because the closed-cycle system at IP2 and IP3 would operate using brackish water, and because the Hudson River does not meet the NRC's definition of a small river, thermal enhancement of microbiological organisms is not expected to be a concern.

Furthermore, as described in Section 4.3 of this draft SEIS, the NRC concludes that continued operation of the facility would not increase the impacts of occupational radiation exposures during the relicensing period. Overall, the NRC staff concludes that human health impacts from the closed-cycle cooling alternative are considered SMALL.

- **Socioeconomics**

Entergy estimates that construction of the cooling towers would require an average workforce of 300 mostly temporary employees or contractors and could take an estimated 62 months.

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During the outage phase of the effort, the temporary workforce could peak at 600 (Entergy 2007). For comparison purposes, a workforce of approximately 950 additional workers is on site during a routine refueling outage (Entergy 2007).

As previously described, the impacts of relicensing and refurbishing IP2 and IP3 are addressed in a site-specific case study presented in Appendix C (Section C.4.4) to the GEIS. The case study postulated that major refurbishment activities could result in as many as 2300 workers on site. In the case study, the workers were engaged in a variety of component replacement and inspection activities. The case study employment estimate is significantly larger than Entergy's estimate in the previous paragraph and is considered by the NRC staff to be the maximum potential size of the temporary workforce because the GEIS estimate includes a variety of activities that will not be occurring at Indian Point during an outage to install a closed-cycle cooling system. As of June 2006 the site had approximately 1255 full-time workers (Entergy employees and baseline contractors) during normal plant operations (Entergy 2007).

The GEIS case study concluded that, because the surrounding counties are high population density areas as described in Section 4.4.1 of this draft SEIS, there will be available housing to support the influx of workers. Therefore, the GEIS concluded that any construction-related impact on housing availability would likely be small. With even fewer workers on site than anticipated in the GEIS, impacts would be even less noticeable.

As reported by Levitan and Associates, Inc. (2005), payments-in-lieu-of-taxes (PILOT) are made by Entergy to surrounding taxing jurisdictions. The PILOT amounts would not likely be affected by the construction of new closed-cycle cooling systems or other capital expenditures. In accordance with the PILOT agreements, this payment schedule will remain fixed through the term of the current site licenses (Levitan and Associates, Inc. 2005). Because plant valuation is not likely to change drastically with the installation of closed-cycle cooling (though it may increase), PILOT payments are likely to stay at similar relative levels throughout the renewal term.

The need for replacement power during construction may affect electricity prices, but the size of this effect depends on the cost of replacement power and the duration of the outages. Plant operators would likely schedule outages to avoid—to the extent possible—summer peak demand periods to avoid affecting grid reliability and power transmission into New York City.

The NRC staff concludes that most socioeconomic impacts related to construction and operation of cooling towers at the site would be SMALL.

- **Transportation**

Neither the NRC nor Entergy has conducted a study of the logistics for construction of cooling towers. However, some adverse transportation impacts are likely. The greatest impacts would likely occur during site excavation and would decline during construction. These impacts would return to current levels following construction.

Offsite disposal of approximately 2 million cy (1.5 million m^3) of rock and soil from the excavation of the two cooling tower sites would be expected to have a significant impact on local transportation infrastructure. As indicated by Entergy, the excavation phase of construction would be expected to take at least 30 months to complete. In Entergy's estimates, over 300,000 round trips would be needed over a period of 30 months to remove the excavated materials in 6-cy dump trucks (370 truckloads per day at 7 days per week or 530 truckloads per

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day at 5 days per week given 10-hour workdays). Traffic in the area is heavy and the additional traffic from construction and site workers would cause increased traffic delays, particularly along US Highway 9 and State Highway 9A (Entergy 2007).

An alternative to shipments of waste by truck may be to ship waste by barge on the Hudson River. Entergy estimates that if 1000-ton barges were used to transport excavation debris, at least five barges per day would have to be loaded and leave the site, with additional barge staging required for returning barges (Entergy 2007). If shipped by barge, the waste would need to be offloaded and likely would be transported by trucks to a disposal site. This would shift the traffic impacts from the trucks to another location but the impacts could still be significant.

During operations, NRC staff anticipates that the closed-cycle cooling system would have little to no effect on transportation, and would likely be limited to occasional shipments of waste cleaned out from cooling tower basins, occasional deliveries of chemicals used to prevent fouling of the towers, and any replacement components necessary throughout the life of the towers. As noted previously, fogging and icing is not expected to be significant.

Based on independent calculations of expected waste volumes from site excavations that were on the same order of magnitude as the Entergy estimates, the NRC staff concludes that impacts from transportation activities, primarily during excavation of the construction site, could be significant and destabilizing, though temporary, during construction and will not be noticeable during operations. Impacts, then, will be SMALL during operations, but LARGE during construction.

- **Aesthetics**

IP2 and IP3 are already visible from the Hudson River, scenic overlooks on area highways, and the Palisades Interstate State Park. The addition of the two cooling towers, standing between 46 and 50 m (150 to 165 ft), would make the entire facility more visible as the developed footprint of the facility would be expanded. The clear-cutting of wooded areas for construction of the towers would remove a visual buffer for some site structures, while the towers may screen out other structures. The towers themselves would be clearly visible from offsite vantage points. Entergy has indicated that it would preserve as many trees as possible and that it would plant new trees to reestablish some visual buffers and help attenuate noise (Entergy 2007). Remaining and new trees could act as a partial visual buffer between the construction sites and the river and a visual and noise buffer on land (Entergy 2007). Construction-related impacts would be relatively short lived.

While the hybrid mechanical-draft cooling towers under consideration are designed to reduce fog and ice production in the local area, fog and ice produced during operation could have an impact on the aesthetics of the surrounding area. In particular, visible drift, though attenuated by the hybrid design, may remain. Less noticeable moisture and salt deposition from the plume may increase dampness and corrosion on surrounding property, which could affect the visual environment. The circular hybrid design proposed by Entergy disperses remaining drift over a greater area at a lower intensity than a single-stage wet mechanical-draft cooling tower (Enercon 2003).

The NRC staff concludes that the impact of construction and operation of a closed-cycle cooling system at IP2 and IP3 on aesthetics would likely be MODERATE, based on the physical

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dimensions of the cooling towers, the size of deforested buffer areas, and the potential for fog and ice resulting from cooled water vapor.

- **Historic and Archeological Resources**

As noted in Section 4.4.5.1 of this draft SEIS, no previously recorded archeological or above ground historic architectural resources are identified on the IP2 and IP3 property. In addition, a Phase 1A survey was conducted on the property in 2006. The NRC staff identified 76 resources listed on the National Register of Historic Places (NRHP) within 5 miles of IP2 and IP3.

There are registered historically significant buildings and sites within several kilometers of IP2 and IP3 and other nonregistered sites or buildings that may be eligible for registration (NRC 1996). However, the NRC case study presented in the GEIS indicated that some unregistered sites may go unprotected because the sites' significance may be discounted because of their proximity to the IP2 and IP3 facility.

Entergy acknowledges that, before construction of cooling towers at the IP2 and IP3 facility can begin, a survey of cultural resources may be needed to identify the potential resources in previously undisturbed areas. The studies would include consultation with the State Historic Preservation Office and appropriate Native American Tribes, as required under Section 106 of the National Historic Preservation Act (NHPA). If historic or archeological resources are present in previously disturbed areas or in undisturbed areas, they would have to be evaluated for eligibility for listing on the NRHP.

Entergy has procedures for addressing historic and archeological resources (as noted in Section 4.4.5.2), it has acknowledged the need to survey for unknown resources before construction, and no significant historical or archeological resources have yet been identified in areas likely to be disturbed. As a result, the NRC staff concludes that the impact from the closed-cycle cooling alternative is likely to be SMALL.

- **Environmental Justice**

The NRC staff addresses environmental justice impacts of continued operations in Section 4.4.6 of this draft SEIS. Construction and operation of cooling towers at IP2 and IP3 would have an impact on environmental justice if environmental impacts of cooling system construction and operation affected minority and low-income populations in a disproportionately high and adverse manner.

Within the 50-mi (80-km) radius of the IP2 and IP3 site, a number of potential environmental impacts (onsite land use, aesthetics, air quality, waste management, and socioeconomic impacts) could affect populations in the immediate vicinity of the site. However, the potentially affected populations for the construction and operation of the closed-cycle cooling alternative, including residents of the Villages of Buchanan and Verplanck, contain low percentages of minority and low-income populations.

Overall, low-income populations within the 50-mi (80-km) radius represent a small percentage of the total population. The low-income population was approximately 11.7 percent of the total population in the combined four-State reference area, or 10.4 percent when the individual States were used as the geographic area. According to 2004 census data, the percentages of people below the low-income criteria in Dutchess and Westchester Counties were 7.7 percent

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and 8.9 percent, respectively.

The 2000 census indicates that 32.1 percent of the population within the 50-mi (80-km) radius and 25.1 percent of the population for the four-State reference area were minority for all races combined. The 2000 census also indicates that the total minority populations of the Villages of Buchanan and Verplanck were 7 percent and 11 percent, respectively.

Therefore, the local populations that would be most directly affected by the proposed action contain lower percentages of minorities and low-income populations than the entire 50-mi (80-km) area and the four-State reference area.

As noted earlier in this section, replacement power required during a 42-week outage could increase air quality effects, depending on the location and characteristics of generator units used to replace IP2 and IP3 output. These effects are likely to be short-lived (most will be no longer than the outage period), and may vary with time of year, scheduled outages at other facilities, and generator pricing on the NYISO grid. Additionally, impacts would occur near existing facilities and would result from incremental increases rather than new effects. As a result, impacts are likely to be small. The NRC staff concludes, then, that the overall environmental justice impacts of constructing and operating a closed-cycle cooling system at the IP2 and IP3 site are likely to be SMALL.

8.1.2 Modified Existing Once-Through Cooling System with Restoration Alternative

The NYSDEC proposal of closed-cycle cooling as the site-specific BTA to protect aquatic life in the draft SPDES permit for IP2 and IP3 (NYSDEC 2003a) is intended to dramatically reduce the entrainment and impingement of aquatic life in the IP2 and IP3 cooling system, thus reducing impacts to fish populations in the Hudson River estuary. Under the terms of the draft SPDES permit, Entergy may propose a different approach that would reduce adverse environmental impacts to an equivalent level (NYSDEC 2003b). The alternative proposed in this section combines the existing once-through cooling system with alternative intake technologies and additional restoration alternatives so that the net impact of the IP2 and IP3 cooling water intake structures is equivalent to the impact from the operation of a new closed-cycle cooling system.

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8.1.2.1 Description of the Modified Existing Once-Through Cooling System with Restoration Alternative

This alternative would reduce impingement and entrainment losses by retrofitting the IP2 and IP3 existing once-through cooling systems with improved intake technology, altering operations of the cooling system, and implementing restoration measures within the Hudson River estuary. Under the terms of the draft SPDES permit, the combined impacts of these actions would have to meet the same performance measures as a closed-cycle cooling system. As described in Section 8.1.1.2 (Aquatic Ecology for the closed-cycle cooling alternative), the amount of water withdrawn from the Hudson River for IP2 and IP3 following implementation of the closed-cycle cooling system alternative would be reduced by 93 to 95 percent. To meet the requirements of the draft SPDES permit (NYSDEC 2003a), the modified once-through cooling system and combined restoration alternatives would have to result in a net entrainment and impingement reduction of 93 to 95 percent for species most affected by the existing system. The NRC staff examined other potential mitigation options to reduce impacts to aquatic life in Section 4.1.5 of this draft SEIS and concludes that one or a combination of these mitigation measures could be used as part of this alternative.

Restoration of wetlands or other aquatic habitats in the Hudson River estuary would likely be included as an aspect of any program designed to offset the residual impacts of once-through cooling-water systems. The New York-New Jersey Harbor is one of the 28 National Estuary Programs charged with developing and implementing a plan to protect, conserve, and restore the estuary (NY-NJ HEP Undated-a). A Comprehensive Conservation and Management Plan (CCMP) establishes priorities for activities, research, and funding for the estuary program. The core areas of the estuary stretch north on the Hudson to Piermont Marsh (south of IP2 and IP3; Piermont Marsh is near the southern end of the Tappan Zee river segment in Figure 2-10 in Chapter 2) (NY-NJ HEP Undated-b), but priorities identified in the CCMP could guide possible restoration activities. In addition, restoration activities would also be conducted in accordance with the NYSDEC Hudson River Estuary Program, a regional partnership designed to protect, conserve, restore, and enhance the estuary.

The estuarine wetlands and shallows of the Hudson River provide foraging habitat and shelter, serve as nursery areas for early life stages and juveniles of fish and shellfish, and contribute to the aquatic food web. An increase in wetlands or other aquatic habitats in the Hudson River estuary could support increased populations of some species affected by the IP2 and IP3 cooling-system operations and thus offset entrainment and impingement losses of those species.

Staff, consultants, or contractors would need to determine where restoration projects should take place before a wetland restoration plan could be designed. The restoration plan would indicate the size and location of restoration projects needed to add to aquatic populations at essentially the levels that the modified once-through cooling system depletes them. Because of the steep slopes on the banks of the river near the IP2 and IP3 facility, there are no significant wetland areas in the immediate vicinity of the site. Therefore, wetland restoration activities would likely need to take place away from the site.

The restoration alternative could build on features of the Hudson River Settlement Agreement (HRSA; addressed in greater depth in Section 2.2.5.3 of this draft SEIS). Measures to limit aquatic impacts of Hudson River Power plants discussed in the HRSA include partial outages

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for some Hudson River power plants during key spawning months, funding and operating a striped bass hatchery, conducting biological monitoring, and setting up a $12-million endowment for a new foundation for independent research on mitigating fish impacts by power plants.

As noted in Chapter 2 of this SEIS, the HRSA was replaced by four consecutive judicially approved consent orders. Each of these consent orders effectively continued the HRSA terms and conditions, with two exceptions. Neither consent order required outages at IP2 or IP3 or the continued operation of the striped bass hatchery.

As described in the draft SPDES permit, financial support of organizations that can have a direct impact on the health of the Hudson River estuary, such as the Hudson River Estuary Restoration Fund (HRERF), is another possible piece of a restoration alternative. The draft SPDES permit would require a payment of $24 million to the HRERF by Entergy (NYSDEC 2003a, 2003c) until it constructs closed-cycle cooling. An alternative to the construction and operation of the closed-cycle cooling systems could include additional funding to the HRERF and groups like it.

8.1.2.2 Environmental Impacts of the Modified Existing Once-Through Cooling System with Restoration Alternative

In this section, the NRC staff discusses the impacts that would occur if the existing once-through cooling system intakes at IP2 and IP3 were modified, and restoration actions were implemented, as described in Section 8.1.2.1 of this draft SEIS. These actions would need to meet the expected requirements of the NYSDEC-issued SPDES permit. The anticipated environmental impacts of this alternative are summarized in Table 8-1 with discussions on each impact category provided in the following paragraphs.

For most issues, the impacts of operating the modified once-through cooling system and restoration alternative would be the same or lower than the impacts associated with the existing once-through cooling system presented in Section 4.1 of this draft SEIS. Only the impacts on land use would likely be greater with the modified cooling system and restoration alternative than with continued operation of the existing system.

- **Land Use**

Any restoration plan will have some impact on land use. Because of the steep slopes on the banks of the river near the IP2 and IP3 facility, there are no significant wetland or shallows areas near the site to support restoration activities. Therefore, restoration activities would likely need to take place at locations further away from the site.

There would be noticeable short-term construction impacts on land use in any areas designated for restoration by the restoration plan. Site preparation could include grading and recontouring, removal of contaminated sediments, and/or replacement of sediments. Restoration often requires the removal of invasive and nonnative plant species through the use of herbicides, prescribed burning, biocontrol, or a combination of techniques. Following the removal of invasive species, the planting of native wetland and upland species along a hydrologic gradient is often required. Restoration activities would likely be conducted in accordance with the NYSDEC Hudson River Estuary program.

Once initial restoration activities are complete, restored wetlands usually require periodic maintenance such as prescribed burning, herbicide application, and planting to maintain the desired mix of native plant species. Monitoring may be required for restored nearshore aquatic

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habitats. These activities could be required throughout the license renewal period. It is unlikely that "operation" of a restoration site will have long-term effects on land use unless restoration converts previously dry land into wetlands. Operation of the restoration site may have some benefits to nearby landowners or users if the site was previously degraded.

Land also would be needed for construction of a new fish hatchery. The impacts to land use would likely be minimal, especially if the construction site was in a previously developed area.

The NRC staff concludes that the activities related to restoration and maintenance of wetlands, and construction and operation of a new fish hatchery, would likely result in SMALL to MODERATE land use impacts.

- **Ecology**

Aquatic ecology. Implementation of a well-developed restoration plan would, as designed, have an overall positive impact on aquatic ecology. There may, however, be some short-term negative impacts during the initial stages of restoration and/or construction activities. A restoration plan would indicate specific locations where restoration activities would take place, as well as the types and duration of activities. In the absence of such a plan, only an estimate of impacts is possible. To achieve performance equivalent to the 93-to-95-percent reduction in impingement and entrainment likely to be achieved with closed-cycle cooling, the restoration alternative would likely also need to include some intake modifications as described in Section 4.1.5 of this draft SEIS, and/or modifications to pumping rates, which could reduce impingement or entrainment.

During wetland restoration and construction of the fish hatchery, the NRC staff expects that impacts to aquatic ecology would be negative. Wetland restoration could initially increase rates of runoff and sedimentation, or release pollutants trapped in sediments. Construction of the fish hatchery could create runoff during construction, though this would likely be minor. During operations, however, any fish hatchery would have to comply with requirements of its own State-issued SPDES permit to control releases of pollutants to any nearby water bodies, likely including the Hudson River.

If this alternative achieves its intended goals—which would require rigorous monitoring—then the NRC staff concludes that the overall net impacts of the cooling system modifications and restoration alternative on aquatic ecology would be SMALL during operation, and MODERATE during construction.

Terrestrial ecology. Implementation of a well-developed restoration plan, cooling system intake modifications, and construction activities will produce few impacts upon the terrestrial environment or threatened or endangered terrestrial species. Impacts to terrestrial ecology would be most noticeable during construction, when any land conversion would take place, and when site crews may need to construct roads or laydown areas for equipment used to restore the wetland or construct the hatchery. Impacts from these activities would be highly site specific, but they are localized and short lived.

Once construction and initial restoration conclude, impacts to terrestrial ecology will be minor, and may be positive for the restoration portion of this alternative. Wetlands can increase the ecological value of nearby land area and provide habitat for some species that are largely terrestrial. Overall, the NRC staff concludes that the terrestrial ecological impacts from the cooling system modification and restoration alternative at IP2 and IP3 would be SMALL to

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MODERATE, as some impacts may be noticeable during construction.

- **Water Use and Quality**

As noted in the Ecology section for this alternative, wetland restoration could initially increase rates of runoff and sedimentation or release pollutants trapped in sediments. Wetland restoration will modify the hydrologic behavior of the restoration site, and often includes measures that can affect surrounding water quality once the site is operational. Hydrologic modifications at a restoration site could include (1) installation of structures that control water flow and affect flow patterns, (2) the removal of dikes or berms, (3) the removal of drainage channels that drain water away from a site, and (4) the creation of new drainage channels or basins. Once operational, wetland restoration sites help to improve surface water quality by allowing natural processes to break down pollutants before being transported into open water.

Construction of the fish hatchery will also create some site runoff, though good construction practices should limit this impact. Once operational, the fish hatchery would have to comply with requirements of its own State-issued SPDES permit to control releases of pollutants to any nearby water bodies, likely including the Hudson River. Fish hatcheries produce nutrient-rich water that may require treatment before release.

While some construction-stage impacts may be noticeable, the long-term operational effects are minor, and may be beneficial. Operational impacts are SMALL, while construction impacts are MODERATE.

- **Air Quality**

Because the restoration alternative contains only relatively small-scale construction projects and does not involve the installation of any major sources of air emissions, it is unlikely that this alternative would trigger noticeable air quality impacts. As a result, the NRC staff concludes that overall impacts to air quality from this alternative would be SMALL.

- **Waste**

Construction of a new fish hatchery would generate a small amount of construction debris, and wetland restoration may leave some land-clearing debris that crews would likely dispose of on site. Any cooling system modification activities are expected to generate modest amounts of wastes for a short period of time. Ongoing operation of the fish hatchery is also expected to generate small amounts of waste, most of which would probably leave the site in liquid form under the restrictions of a State-issued discharge permit. Therefore, the NRC staff concludes that waste-related impacts associated with the cooling system modification and restoration alternative at IP2 and IP3 would be SMALL.

- **Human Health**

Construction of a new fish hatchery would present some general construction-related occupational hazards, as would installation of cooling system modifications. Wetland restoration activities also would present some occupational and environmental exposure hazards. Restoration activities may have positive effects if they improve the quality of water in portions of the Hudson that supply drinking water, as well as to the extent that they provide unpolluted habitat for fish or shellfish that humans may consume.

As described in Section 4.3 of this draft SEIS, the NRC concludes that continued operation of

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the facility would not increase the impacts of occupational radiation exposures during the relicensing period, nor would they likely affect radiation exposures to the public. Furthermore, there would be no significant noise sources associated with construction or operation of the fish hatchery or restoration activities that could not be effectively mitigated to protect site workers or offsite individuals.

Overall, the NRC staff concludes that human health impacts from the cooling system modification and restoration alternative are SMALL.

- **Socioeconomics (including Transportation)**

Section 4.4 of this draft SEIS describes the socioeconomic impacts of the continued operation of the IP2 and IP3 facility. The cooling system modification and restoration alternative at IP2 and IP3 would not significantly change employment at or near IP2 and IP3. There would also be no significant changes in the tax base for the region or in traffic flow or traffic patterns.

Therefore, the NRC staff concludes that overall socioeconomic impacts of the alternative would be SMALL.

- **Aesthetics**

The proposed restoration alternative would have no significant impact on the aesthetic value of the IP2 and IP3 facility. Cooling system modification and restoration likely would not have any onsite impacts that would change the overall appearance of the site. Wetland restorations could have a long-term positive impact on aesthetics, or at least minimal negative impacts. Construction of a new fish hatchery would have limited visual effects because most structures (tanks or ponds, storage buildings, pumphouses) are unobtrusive. Even if some negative impacts occur during construction, long-term negative impacts during operation are unlikely.

The NRC staff concludes that the impact of the cooling system modification and restoration at IP2 and IP3 on aesthetics would be SMALL.

- **Historic and Archeological Resources**

As noted in Section 4.4.5.1 of this draft SEIS, no previously recorded archeological or above-ground historic architectural resources have been identified on the IP2 and IP3 site. In addition, a Phase 1A survey was conducted for the site in 2006. The NRC staff identified 76 resources listed on the NRHP within 5 miles of IP2 and IP3.

The NHPA requires archeological surveys to identify and evaluate historic and archeological resources in areas identified for restoration and construction would be required before initiation of ground-disturbing activities. The studies would include consultation with the State Historic Preservation Office (NYSHPO) and appropriate American Indian Tribes.

Many shell midden sites (ancient shell mounds) or other signs of past human activities occur adjacent to wetland areas, and such sites may be encountered during surveys. Aspects of the NHPA require that lands not previously surveyed be investigated by a professional archeologist in consultation with the NYSHPO before any ground-disturbing activities. Through consultation, whatever entity constructs the fish hatchery or wetland restoration site would identify ways to reduce or avoid adverse impacts. It is possible that construction may have a noticeable effect on historic and archeological resources.

Once operational, the restoration option would essentially have no impact on historic or

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archeological resources. The impact of restoration and construction on historic and archeological resources could range from SMALL during operation to MODERATE during construction, depending on the locations chosen for wetland restoration and construction of a new fish hatchery, the number of sites recorded in those locations, and whether the recorded sites are significant (i.e., eligible for listing on NRHP).

- **Environmental Justice**

Section 4.4.6 of this draft SEIS discusses the environmental justice impacts of continued plant operation. Modification to the existing once-through cooling system intakes at IP2 and IP3 and restoration of wetlands could have an impact on environmental justice if environmental impacts of modifications affected minority and low-income populations in a disproportionately high and adverse manner.

However, as described in Section 8.1.1.1 of this draft SEIS, under the Environmental Justice section, the local populations that would be most affected by the proposed action contain lower percentages of minorities and low-income populations than the entire 50-mi radius area and the four-State reference area. As such, the NRC staff concludes that the environmental justice impacts of the modified once-through cooling system and restoration alternative at the IP2 and IP3 site would be SMALL.

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Table 8-1. Summary of Environmental Impacts of a Closed-Cycle Cooling Alternative and a Modified Existing Once-Through Cooling System with Restoration Alternative at IP2 and IP3

Impact Category	New Closed-Cycle Cooling Alternative		Once-Through Cooling with Restoration Alternative	
	Impact	Comments	Impact	Comments
Land Use	SMALL to LARGE	Construction of towers requires about 16 ha (40 ac). Waste disposal may require much offsite land.	SMALL to MODERATE	Short-term land disturbances may result from habitat restoration; land use changes at the fish hatchery site.
Ecology: Aquatic	SMALL	Entrainment and impingement of aquatic organisms, as well as heat shock would be reduced substantially.	SMALL to MODERATE	Entrainment and impingement of aquatic organisms reduced, while restoration of habitat benefits many species. Noticeable impacts occur during construction.
Ecology: Terrestrial	SMALL to MODERATE	Onsite forest habitats disturbed while drift from towers may affect vegetation.	SMALL to MODERATE	Impacts may occur from offsite construction and temporary impacts in the restoration area. Operational issues are minor.
Water Use and Quality	SMALL	Releases to surface water would be treated as necessary to meet permit requirements. Runoff from construction activities is likely to be controlled.	SMALL to MODERATE	Short-term impacts from construction and restoration can be controlled using management practices, though noticeable impacts may occur.

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Table 8-1 (continued)

Impact Category	New Closed-Cycle Cooling Alternative		Existing Once-Through Cooling with Restoration Alternatives	
	Impact	Comments	Impact	Comments
Air Quality	SMALL	Primary impacts from vehicles and equipment emissions during construction, as well as replacement power. Existing regulations should limit effects.	SMALL	Minor impacts from fugitive dust and emissions from vehicles and equipment occur during construction.
Waste	SMALL to LARGE	Construction would generate about 2 million cy of soil, rock, and debris requiring offsite disposal.	SMALL	Activities would generate easily managed volumes of waste.
Human Health	SMALL	Workers experience minor accident risk during construction. No impacts on human health during operation.	SMALL	Workers experience minor accident risk during construction. No negative impacts on human health during operation.
Socioeconomics	SMALL	No impact to offsite housing or public services occurs.	SMALL	This alternative creates insignificant changes in area employment levels or tax revenues.
Transportation	SMALL to LARGE	Increased traffic associated with construction (workers and waste disposal) would be significant, though little effect during operations.	SMALL	Insignificant changes in traffic volumes result.
Aesthetics	MODERATE	Construction of two towers,150 to 165 ft tall, would have a noticeable impact on the aesthetics of the site. Minor plume and noise issues could occur.	SMALL	Onsite aesthetics would not likely change significantly. Wetland restorations would have a long-term positive effect on aesthetics.

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Table 8-1 (continued)

Impact Category	New Closed-Cycle Cooling Alternative		Existing Once-Through Cooling with Restoration Alternatives	
	Impact	Comments	Impact	Comments
Historical and Archeological Resources	SMALL	Existing procedures are adequate to protect resources on the largely-disturbed site.	SMALL to MODERATE	Impacts could reach moderate during construction in sensitive areas.
Environmental Justice	SMALL	No significant impacts are anticipated that could disproportion-ately affect minority or low-income communities.	SMALL	No significant impacts are anticipated that could disproportion-ately affect minority or low-income communities.

8.2 No-Action Alternative

The NRC regulations implementing the National Environmental Policy Act of 1969, as amended (NEPA) (see 10 CFR Part 51, Subpart A, Appendix A, paragraph 4), specify that the no-action alternative will be discussed in an NRC environmental impact statement.

For license renewal, the no-action alternative refers to a scenario in which the NRC would not renew the IP2 and IP3 operating licenses and Entergy would then cease operating both units on or before the expiration of their current operating licenses. Following the shutdown of each unit, Entergy would initiate decommissioning of the facility in accordance with the NRC decommissioning requirements in 10 CFR 50.82, “Termination of License.” Full dismantling of structures and decontamination of the site may not occur for up to 60 years after plant shutdown.

Regardless of whether or not the IP2 and IP3 operating licenses are renewed, the facility’s owner will eventually be required to shut down the reactors and decommission the IP2 and IP3 facility. If the operating licenses are renewed, shutdown and decommissioning activities would not be avoided but would be postponed for up to an additional 20 years.

The environmental impacts associated with decommissioning, following a license renewal period of up to 20 years or following the no-action alternative, would be bounded by the discussion of impacts in Chapter 7 of the GEIS, Chapter 7 of this draft SEIS, and NUREG-0586, “Final Environmental Impact Statement on Decommissioning of Nuclear Facilities” (NRC 2002). The impacts of decommissioning after 60 years of operation are not expected to be significantly different from those occurring after 40 years of operation.

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Table 8-2. Summary of Environmental Impacts of the No-Action Alternative

Impact Category	Impact	Comment
Land Use	SMALL	Impacts are expected to be SMALL because plant shutdown is expected to result in few changes to offsite and onsite land use, and transition to alternate uses is expected over an extended timeframe.
Ecology	SMALL	Negative impacts to aquatic ecology of the Hudson River will cease. The overall impact is SMALL.
Water Use and Quality	SMALL	Impacts are expected to be SMALL as no new impacts occur with plant shutdown.
Air Quality	SMALL	Impacts are expected to be SMALL because emissions related to plant operation and worker transportation will decrease.
Waste	SMALL	Impacts are expected to be SMALL because generation of high-level waste will stop and generation of low-level and mixed waste will decrease.
Human Health	SMALL	Impacts are expected to be SMALL because radiological doses to workers and members of the public, which are within regulatory limits, will be reduced.
Socioeconomics	SMALL to MODERATE	Impacts vary by jurisdiction, with some areas experiencing MODERATE effects.
Socioeconomics (Transportation)	SMALL	Impacts are expected to be SMALL because the decrease in employment would reduce traffic.
Aesthetics	SMALL	Impacts are expected to be SMALL because plant structures will remain after plant shutdown.
Historic and Archeological Resources	SMALL	Impacts are expected to be SMALL because shutdown of the plant will not immediately change land use.
Environmental Justice	SMALL	Impacts are expected to be SMALL because there are no significant disproportionate impacts to minority or low-income populations.

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Impacts from the decision to permanently cease operations are not considered in NUREG-0586, or its Supplement 1.[2] Therefore, immediate impacts that occur between plant shutdown and the beginning of decommissioning are considered here. These impacts will occur when the units shut down regardless of whether the license is renewed (see Table 8-2).

Plant shutdown will result in a net loss of power generating capacity. The power not generated by IP2 and IP3 during the license renewal term would likely be replaced by (1) power supplied by other producers (either existing or new units) using generating technologies that may differ from that employed at IP2 and IP3, (2) demand-side management and energy conservation, or (3) some combination of these options. The environmental impacts of these options are discussed in Section 8.3 of this draft SEIS. While these options can be alternatives to license renewal (given sufficient resource availability), they also constitute potential consequences of the no-action alternative. Impacts from these options will addressed in their respective portions of this Section.

This draft SEIS does not assess the specifics of the need for corrections to reactive power that would be required if IP2 and IP3 were shut down. Reactive power (i.e., power stored in magnetic fields throughout the power grid) is essential for the smooth operation of the transmission grid because it helps hold the voltage to desired levels. It may be possible to use the existing generators at IP2 and IP3 as a source of reactive power even if IP2 and IP3 are shut down. As "synchronous condensers," the generators could add reactive power (but not real power) to the transmission system (National Research Council 2006). Because it is assumed that the generators would be operated as synchronous condensers only until the reactive power could be supported by new, real replacement power generation, their operation is not considered as a significant contributor to the impacts described below. Further, as a shut-down nuclear power plant may not be decommissioned for many years after shutdown, the continued operation of IP2 and IP3 generators would not necessarily slow or impede decommissioning activities.

- **Land Use**

In Chapter 4 of this draft SEIS, the NRC staff concluded that the impacts of continued plant operation on land use would be SMALL. Onsite land use will not be affected immediately by plant shutdowns. Plant structures and other facilities are likely to remain in place until decommissioning. In the near term, the transmission lines associated with IP2 and IP3 will likely remain in place. In the long term, it is possible that the transmission lines that extend from the onsite switchyard to major transmission corridors will be removed. As a result, the transmission line ROWs will no longer be maintained and the ROW will be available for other uses. Also, as a result of plant shutdowns, there would be a reduction in uranium mining activity on approximately 870 ha (2160 ac), or 405 ha (1000 ac) per 1000 MW(e) (NRC 1996). Therefore, the staff concludes that the impacts on land use from plant shutdown would be SMALL.

- **Ecology**

In Chapter 4 of this draft SEIS, the NRC staff concluded that aquatic ecological impacts of

[2] Appendix J, "Socioeconomic and Environmental Justice Impacts Related to the Decision to Permanently Cease Operations," to NUREG-0586, Supplement 1, discusses the socioeconomic impacts of plant closure, but the results of the analysis in Appendix J are not incorporated in the analysis presented in the main body of the NUREG.

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continued plant operation were SMALL to LARGE because of the entrainment and impingement of aquatic species, depending on the species. The NRC staff also concluded that thermal shock could have a SMALL to MODERATE impact. Terrestrial ecological impacts were SMALL. Cessation of operations will eliminate cooling water intakes from and discharges to the Hudson River. The environmental impacts to aquatic species, including threatened and endangered species, associated with these changes are generally positive because entrainment and impingement issues will be eliminated, as would impacts from the plant's thermal plume. The NRC staff expects that impacts to aquatic ecology, including to the endangered shortnose sturgeon, would decline to SMALL if the plant shuts down.

The impacts of plant closure on the terrestrial ecosystem could be both negative and positive, depending on final disposition of the IP2 and IP3 site. Currently, there is a fragment of eastern deciduous hardwood habitat in the exclusion area of the facility that Entergy indicates has not been previously developed. This fragment could be destroyed by new development once access is no longer restricted. Plant closure will not directly affect this fragment, however, and a prolonged period prior to site decontamination may also provide protection for this fragment. Overall, the NRC staff concludes that ecological impacts from shutdown of the plant would be SMALL.

- **Water Use and Quality**

When the plant stops operating and cooling water is no longer needed, there will be an immediate reduction in water withdrawals from and discharge to the Hudson River. This will reduce evaporation from the river in the vicinity of the plant and will result in decreased discharges of biocides and other chemicals. Therefore, the staff concludes that the impacts on surface water use and quality from plant shutdown would be less noticeable than current operations and would remain SMALL.

Ground water at the IP2 and IP3 site contains elevated concentrations of tritium (EPA 2004). In Sections 2.2.7 and 4.5 of this draft SEIS, the NRC staff examined available information on leakage to ground water and determined that the issue, while new, is not significant. The source of the contamination is believed to be historical leakage from the IP1 and IP2 spent fuel pools. Since discovering the leaks, Entergy has removed fuel from the IP1 spent fuel pool and drained it. The no-action alternative would not, on its own, affect ground water contamination. Consequently, the NRC staff concludes that ground water quality impacts from shutdown of the plant would be SMALL.

- **Air Quality**

In Chapter 4 of this draft SEIS, the NRC staff adopted the findings in the GEIS that the impacts of continued plant operation on air quality would be SMALL. When the plant stops operating, there will be a reduction in emissions from activities related to plant operation (e.g., use of diesel generators and vehicles to transport workers to the site). As such, the NRC staff concludes that the impact on air quality from shutdown of the plant would be SMALL.

- **Waste**

The impacts of waste generated by continued plant operation are discussed in Chapter 6 of this draft SEIS. The impacts of low-level and mixed waste from plant operation are characterized as SMALL. When IP2 and IP3 stop operating, the plant will stop generating high-level waste and generation of low-level and mixed waste associated with plant operation will briefly increase,

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and then will decline. Therefore, the staff concludes that the impacts of waste generated after shutdown of the plant would be SMALL.

Wastes associated with plant decommissioning are unavoidable and will be significant whether the plant is decommissioned at the end of the initial license term or at the end of the period of extended operation. The no-action alternative will not have an appreciable affect on waste volumes associated with decommissioning.

- **Human Health**

In Chapter 4 of this draft SEIS, the NRC staff concluded that the impacts of continued plant operation on human health are SMALL. After cessation of plant operations, the amount of radioactive material released to the environment in gaseous and liquid forms, which are currently within regulatory limits, will be reduced. Therefore, the NRC staff concludes that the impact of plant shutdown on human health also would be SMALL. In addition, the variety of potential accidents at the plant will be reduced to a limited set associated with shutdown events and fuel handling. In Chapter 5 of this draft SEIS, the staff concluded that impacts of accidents during operation are SMALL. Therefore, the NRC staff concludes that the impacts of potential accidents following shutdown of IP2 and IP3 also would be SMALL.

- **Socioeconomics**

In Chapter 4 of this draft SEIS, the NRC staff concluded that the socioeconomic impacts of continued plant operation would be SMALL. Should the plant shut down, there would be immediate socioeconomic impacts from loss of jobs (some, though not all, of the approximately 1255 full-time employees and baseline contractors would begin to leave the site); there may also be an immediate reduction in property tax revenues for Westchester County. These impacts, however, would not be considered significant on a countywide basis because of the large population in the area and because plant workers' residences are not concentrated in a single municipality or county.

PILOT payments and other taxes from IP2 and IP3 are paid directly to the Town of Cortlandt, the Village of Buchanan, and the Hendrick Hudson Central School District. Entergy paid a combined $21.2 million in PILOT payments, property taxes, and other taxes to Westchester County, the Town of Cortlandt, the Village of Buchanan, the Verplanck Fire District, and the Hendrick Hudson Central School District in 2005 (Entergy 2007). PILOT payments, property taxes, and other taxes paid by the site account for a significant portion of revenues for these Government agencies.

The Village of Buchanan, which has over 2100 residents, is the principal local jurisdiction that receives direct revenue from IP2 and IP3. In fiscal year 2005, PILOT payments, property taxes, and other taxes from Entergy contributed about 39 percent of the Village of Buchanan's total revenue of $5.08 million (Entergy 2007). The revenues generated from IP2 and IP3 are used to fund police, fire, health, transportation, recreation, and other community services. Additionally in fiscal year 2005, PILOT payments, property taxes, and other taxes from Entergy contributed over 35 percent of the total revenue collected for the Hendrick Hudson Central School District, which serves approximately 3000 students (Entergy 2007).

The shutdown of IP2 and IP3 may result in increased property values of the homes in the communities surrounding the site (Levitan and Associates, Inc. 2005). This would result in some increases in tax revenues. However, to fully offset the revenues lost from the shutdown of

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IP2 and IP3, taxing jurisdictions most likely would have to compensate with higher property taxes (Levitan and Associates, Inc. 2005). The combined increase in property values and increased taxes could have a noticeable effect on some area homeowners and business, though Levitan and Associates did not indicate the magnitude of this effect and whether the net effect would be positive or negative.

Revenue losses from Indian Point operation would likely affect only the communities closest to and most reliant on the plant's tax revenue and PILOT. If property values and property tax revenues increase, some of these effects would be smaller. The NRC staff concludes that the socioeconomic impacts of plant shutdown would likely be SMALL to MODERATE (MODERATE effects for the Hendrick Hudson Central School District, Village of Buchanan, Town of Cortlandt, and the Verplanck Fire District). See Appendix J to NUREG-0586, Supplement 1 (NRC 2002), for additional discussion of the potential impacts of plant shutdown.

- **Transportation**

In Chapter 4 of this draft SEIS, the NRC staff concluded that the impacts of continued plant operation on transportation would be SMALL. Cessation of operations will be accompanied by reduced traffic in the vicinity of the plant. Most of the reduction will be associated with a reduction in plant workforce, but there will also be a reduction in shipment of maintenance materials to and from the plant. Therefore, the staff concludes that the impacts of plant closure on transportation would be SMALL

- **Aesthetics**

In Chapter 4 of this draft SEIS, the NRC staff concluded that the aesthetic impacts of continued plant operation would be SMALL. Major plant structures and other facilities, such as the containment buildings and turbine buildings, are likely to remain in place until decommissioning begins. The NRC staff also anticipates that the overall appearance of the facility and its grounds would be maintained through the decommissioning. Since no significant changes would occur between shut down and decommissioning, the staff concludes that the aesthetic impacts of plant closure would be SMALL.

- **Historic and Archeological Resources**

In Chapter 4 of this draft SEIS, the staff concluded that the impacts of continued plant operation on historic and archeological resources would be SMALL. Onsite land use will not be affected immediately by the cessation of operations since plant structures and other facilities are likely to remain in place until decommissioning. Following plant shutdown, there would be no foreseeable need for archeological surveys of the area. Therefore, the NRC staff concludes that the impacts on historic and archeological resources from plant shutdown would be SMALL.

- **Environmental Justice**

In Chapter 4 of this draft SEIS, the NRC staff concluded that the environmental justice impacts of continued operation of the plant would be SMALL because continued operation of the plant would not have a disproportionately high and adverse impact on minority and low-income populations. Although the NRC staff concluded that the socioeconomic impacts of the plant shutdown would be MODERATE for some jurisdictions, the impacts of the plant shutdown are likely to be felt across the entire community and are not expected to be significantly disproportionate to minority and low-income populations.

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As described in Section 2.2.8.6, the site contributed over 35 percent of the total revenue collected for the Hendrick Hudson Central School District in 2005. The Hendrick Hudson Central School District has only an 18-percent minority population (compared to a 47-percent Statewide average) and only 5 percent of the students are eligible for a free or reduced-price lunch program (compared to a Statewide average of 44 percent). Therefore, the loss of funding to the Hendrick Hudson Central School District would not disproportionately affect minority and low-income populations (GreatSchools 2008).

The site contributed about 39 percent of the Village of Buchanan's total revenue in 2005 (Entergy 2007). In 2000, less than 4 percent of the population were minorities and less than 4 percent of the individuals were below the poverty level (US Census Bureau 2000). Therefore, the loss of funding to the Village of Buchanan would not disproportionately affect minority and low-income populations.

The NRC staff concludes that the environmental justice impacts of plant shutdown would be SMALL. See Appendix J to NUREG-0586, Supplement 1 (NRC 2002), for additional discussion of these impacts.

8.3 Alternative Energy Sources

This section discusses the environmental impacts associated with developing alternative sources of electric power to replace power generated by IP2 and IP3. The order of alternative energy sources presented in this section does not imply which alternative would be most likely to occur or which is expected to have the least environmental impacts.

The following central generating station alternatives are considered in detail in the identified sections of this draft SEIS:

- supercritical coal-fired generation at an alternate site (Section 8.3.1)
- natural gas-fired generation at either the IP2 and IP3 site or an alternate site (Section 8.3.2)

The NRC staff considers the following nongeneration alternatives to license renewal in detail in the identified sections of this draft SEIS:

- purchased power (Section 8.3.3)

The NRC staff also considers two combinations of alternatives that include new or existing generation along with conservation or purchased power in the identified sections of this draft SEIS:

- continued operation of either IP2 or IP3, construction and operation of a gas-fired unit, renewable generation, and conservation programs (Section 8.3.5.1)
- construction and operation of new gas-fired plant, renewable generation, conservation, and purchased power (Section 8.3.5.2)

Alternatives considered by the NRC staff but dismissed from further evaluation as stand-alone alternatives are addressed in Section 8.3.4 of this draft SEIS. Several of the alternatives discussed in Section 8.3.4 are included in the combinations addressed in 8.3.5.

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Alternatives Process

Since IP2 and IP3 have a net electric output of 2158 MW(e), the NRC staff evaluated the impacts of alternatives with comparable capabilities.

Of the alternatives mentioned in this section, the NRC staff expects that only a natural gas-fired generation plant could be developed at the IP2 and IP3 facility because the site is too small to host other alternatives.

While the alternate site considered need not be situated in New York State, the availability of transmission line capacity to deliver power from a location outside the New York metropolitan region to current IP2 and IP3 customers could constrain siting choices. For instance, a recent analysis conducted by the U.S. Department of Energy (DOE) concluded that metropolitan New York southward through northern Virginia is a "critical congestion area" (DOE 2006). The DOE has identified critical congestion areas where it is critically important to remedy existing or growing electrical transmission congestion problems because the impacts of the congestion could be severe. It is conceivable that these transmission congestion patterns would influence selection of an alternate site for generating power that is needed in the New York metropolitan region.

All of New York's constrained transmission paths move power from areas to the west, south, and north of the State to the loads in and around New York City and Long Island. The New York City metropolitan area consumes major quantities of electricity with less generation capacity than load. Therefore, the region is dependent on imports. Because of the area's current dependence on local power generation from natural gas and oil fuels, the area has high electricity rates (DOE 2006). The replacement of limited local generation sources with additional imported power would place even more demands on the constrained transmission system moving power into the New York City area. As noted in Section 8.2, it may be necessary to continue operating the IP2 and IP3 generators as synchronous condensers to supply virtual power to the local transmission system after the IP2 and IP3 reactors shut down.

EIA Projections

Each year the Energy Information Administration (EIA), a component of DOE, issues an annual energy outlook. In its "Annual Energy Outlook 2007 with Projections to 2030," EIA projects that natural gas-fired plants will account for approximately 26 percent of electric generating capacity in 2020, an increase of about 14 percent from 2005 levels (DOE/EIA 2007a). EIA projects that coal-fired plants will account for approximately 32 percent of generating capacity in 2020, increasing nearly 15 percent from 2005 levels (DOE/EIA 2007a). EIA projects that renewable energy sources, primarily hydropower and biomass, will account for 12 percent of capacity in 2020, increasing from 9 percent in 2005 (DOE/EIA 2007a). After 2020, however, new coal and nuclear plants are expected to displace some of the power currently generated at natural-gas-fired plants (DOE/EIA 2007a).

EIA bases its projections on the assumption that providers of new generating capacity will seek to add generating sources that are cost effective and meet applicable environmental requirements. According to EIA, advanced coal-fired and advanced combined-cycle natural gas generating facilities will be approximately competitive with each other in 2015, and advanced coal-fired facilities will likely gain a competitive edge by 2030 (DOE/EIA 2007a). In line with the EIA projections, the alternative of a new advanced coal-fired plant at an alternate location is considered in this draft SEIS. The resulting impacts are presented in Section 8.3.1 of this draft

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SEIS. The impacts of a new gas-fired combined-cycle plant located at either the IP2 and IP3 site or an alternate site are presented in Section 8.3.2 of this draft SEIS.

EIA indicated that, because of environmental needs and increasing fuel costs, oil-fired plants will account for little or none of the new generating capacity added in the United States through 2030 (DOE/EIA 2007a). This projection assumed that world oil prices would reach a low of $50 per barrel in 2014 and rise to $59 in 2030. After recent sharp price increases and declines, the EIA now projects that oil prices will average $51 per barrel in 2009 (DOE/EIA 2008b). The NRC staff notes that future oil prices will be driven by supply and demand.

The EIA projects that U.S. generators will increase total nuclear and renewable generation capacity throughout the forecast term, due partly to tax credits and other incentives. As a proportion of installed capacity, however, nuclear generation will decrease slightly through 2030, while renewable generation remains relatively constant (EIA 2007). EIA indicates that changes in electricity generation costs—which are highly dependent on emission control costs—will drive utilities' choices in generating technologies (EIA 2007). About 70 percent of new nuclear generating capacity is expected to be directly related to the availability of production tax credits under the Energy Policy Act of 2005 (EPACT2005; DOE/EIA 2007a).

The NRC staff uses EIA's analyses to help select reasonable alternatives to license renewal. In the following sections of this chapter, the NRC staff will examine several alternatives in depth, and identify a range of others that staff considered but rejected.

8.3.1 Supercritical Coal-Fired Generation

In this section, the NRC staff analyzes new supercritical coal-fired boilers as an alternative to nuclear power generation at the IP2 and IP3 site. Supercritical coal-fired plants are similar to other coal burners except that they operate at higher temperatures and pressures, which allows for greater thermal efficiency. Supercritical coal-fired boilers are commercially proven and represent an increasing proportion of new coal-fired power plants. In evaluating the supercritical coal-fired alternative, the NRC staff assumed that a new plant located at an alternate site would use a closed-cycle cooling system.

The NRC staff recognizes that some coal-fired power plant proposals have recently faced opposition or rejection in some jurisdictions, though other projects continue to move forward. Also, coal-fired generation faces greater regulatory uncertainty and risk from potential future greenhouse gas regulation than other generation alternatives. In New York, coal-fired power plants would need to comply with elements of the Regional Greenhouse Gas Initiative. Nonetheless, given EIA's projections and the progress of some new coal-fired proposals, the NRC staff has decided to include coal-fired generation as an alternative to license renewal.

Construction of a coal-fired plant at an alternate site may necessitate the acquisition of additional ROWs for new transmission lines and construction of new lines to transmit power. Transmission line and ROW length would vary with distance to suitable existing lines. In addition, construction at an alternate site may necessitate the construction of an appropriate railroad spur (or other transportation infrastructure) for coal and limestone (used in scrubbers to remove sulfur oxides) deliveries.

For purposes of this analysis, the NRC staff will rely on data published by EIA indicating that a new, scrubbed coal plant constructed in 2015 will operate at a heat rate of 8661 BTU per

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kilowatt hour (BTU/kWh) (DOE/EIA 2007b). (This reduces the level of emissions for this alternative when compared to the coal-fired alternative Entergy analyzed in the ER for IP2 and IP3 ER by approximately 15 percent for some impact areas).

Impacts of a coal-fired alternative evaluated by the NRC staff assume that the new plant would have a gross electrical capacity of 2200 MW(e). The NRC staff's analysis of the 2200-MW(e) coal-fired plant is based on the factors used to calculate the impacts of the plant that would replace the 2158 MW(e) of power produced by the IP2 and IP3 plants (Entergy 2007). Because up to 10 percent of gross generation may be consumed on site by the coal-fired plant (or its pollution control equipment), the NRC staff's evaluation of a 2200-MW(e) plant may actually slightly understate impacts from this alternative. This ensures, however, that impact levels for alternatives are not overstated when compared to the proposed action.

The NRC staff will present most impacts on an annualized basis. While the renewal period for the IP2 and IP3 operating licenses is only 20 years, the operating lifespan for a new coal-fired plant is likely closer to 40 years, and may even be longer given the lifespans of some existing coal-fired plants. Most impacts will be independent of plant lifespan, though total land area used for waste disposal, for example, will be larger after 40 years than after 20 years. Where these differences exist, the NRC staff will identify them.

For replacing IP2 and IP3, the NRC evaluated an alternative that would use four 550-MW(e)-net coal-fired units to replace the power output of IP2 and IP3. Advanced coal and conventional combined-cycle coal plants could operate at even greater efficiencies (about 7477 and 6866 BTU/kWh, respectively, or greater) by 2015 (DOE/EIA 2007b).

The supercritical coal-fired plant, with a gross output of about 2200 MW(e), would consume approximately 4.9 million metric tonnes (MT) (5.4 million tons) per year of pulverized bituminous coal with an ash content of approximately 7.11 percent and sulfur content of 1.12 percent (based on New York coal consumption) (DOE/EIA 2001). The NRC staff assumed a capacity factor of 0.85 for the supercritical coal-fired alternative.

Based on Table 8-1 of the GEIS, a pulverized coal-fired facility requires approximately 0.7 ha (1.7 ac) of land per MW of generating capacity. Based on this relationship, a 1540-ha (3740-ac) site would be needed to replace the nuclear power output of IP2 and IP3 with an equivalent capacity coal-fired facility. In more recent SEIS documents, however, the NRC staff indicated that smaller quantities of land may be sufficient to construct coal-fired facilities based on land use at existing coal-fired power plants. Because the existing IP2 and IP3 site includes only 239 ac (98 ha), and much of the area is occupied by plant structures, the NRC staff concludes that there is not sufficient land area at the IP2 and IP3 site to support operations of the alternative. Thus, the coal-fired alternative is analyzed only for an unspecified alternate site. It should be noted that several of the newer coal utilization technologies (e.g., coal-fired integrated gasification combined-cycle systems) could be accommodated on smaller sites than would the conventional pulverized coal concept evaluated here, but likely not a site as small as the IP2 and IP3 site.

The overall impacts of the coal-fired generating facility are discussed in the following sections and summarized in Table 8-3, at the end of Section 8.3.1 of this draft SEIS. The implications of constructing a new coal-fired plant at an alternate site will depend on the actual location and characteristics of that site. For purposes of this section, the NRC staff assumes that a coal-fired plant located at an alternate site would require the construction of a new transmission line to

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connect that plant to the regional transmission grid.

- **Land Use**

In the GEIS, the NRC staff estimated that about 0.7 ha (1.7 ac) of land are needed per MW(e) for the construction and operation of a coal-fired power plant. Constructing a 2200-MW(e) coal-fired facility would take approximately 1540 ha (3740 ac). In more recent SEIS documents, the NRC staff indicated that smaller quantities of land may be sufficient to construct coal-fired facilities based on land use at existing coal-fired power plants. A 2200-MW(e) facility may be able to fit on a site with several hundred acres of land rather than the 1540 ha (3740 ac) indicated in the GEIS.

Committing land resources to a new coal-fired plant could result in the loss of wildlife habitat or agricultural land. The potential need for new transmission line corridors and ROWs also drive land use effects for the coal-fired facility. As a result of the substantial site area that would be dedicated to and disrupted by coal-fired operations, the NRC staff views this alternative as having potentially MODERATE land use impacts from construction.

Additionally, for the coal-fired alternative, land use changes would occur at an undetermined coal mining area where approximately 75 square miles (sq mi) (19,400 ha) would be affected for mining coal and disposing of mining wastes to support a 2200-MW(e) coal-fired power plant (the GEIS estimates that approximately 34 sq mi (8800 ha) would be disturbed for a 1000-MW(e) coal-fired plant (NRC 1996). Offsite land use for coal mining would partially be offset by the elimination of the need for offsite uranium mining. In the GEIS, the NRC staff estimated that approximately 405 ha (1000 ac) would be affected for mining the uranium and processing it during the operating life of a 1000-MW(e) nuclear power plant (NRC 1996). Therefore the uranium mining offset would be about 890 ha (2,200 ac) of the 19,400 ha required for the coal-fired alternative. Impacts from the coal fuel cycle would add to the already MODERATE impacts from plant construction.

A coal-fired alternative would likely receive coal and limestone by rail. The coal-fired option would require approximately 10.4 coal unit trains per week (assuming each train has 100 cars with 100 tons of coal per car). For an undeveloped site, a new rail spur would be necessary. For an existing industrial site, a rail spur may exist but could require improvements to handle these deliveries. Impacts from improving an existing rail spur would be small, as the area is already disturbed and used for industrial purposes. Installing a new rail spur could result in relatively minor impacts depending on the length of the rail spur.

Overall, impacts to land use from construction of the coal-fired alternative and its fuel cycle would be MODERATE to LARGE.

- **Ecology**

Siting a coal-fired plant at an alternate site would introduce construction and operating impacts. Converting as much as 1500 ha (3700 ac) of land to industrial use (generating facilities, coal storage, ash and scrubber sludge disposal) could significantly alter terrestrial ecological resources and could affect aquatic ecological resources. Construction and maintenance of a transmission line and rail spur would incrementally add to the terrestrial ecological impacts. Impacts to terrestrial ecology from coal mining also could be substantial, though terrestrial ecology at many coal mining sites has already been disturbed. Therefore, the NRC staff concludes that the impact to terrestrial ecology would be MODERATE to LARGE, depending

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largely on the ecological sensitivity of the plant and mine sites.

Use of surface water resources to provide makeup water for a closed-cycle cooling system would have some impact on local aquatic resources. Aquatic impacts of a supercritical coal-fired alternative would likely be similar to the impacts of the proposed closed-cycle cooling system proposed for the existing nuclear reactors described in Section 8.1.1 of this draft SEIS. The supercritical coal-fired power plant's greater thermal efficiency—when compared to the existing IP2 and IP3—would result in smaller impacts, while the coal-fired alternative has greater potential for deposition of pollutants or runoff from coal, ash, or scrubber waste areas. On the whole, the level of impact would be similar. Therefore, the NRC staff concludes that the impact to aquatic ecology would be SMALL.

Due primarily to the potential effects on terrestrial ecology, the NRC staff concludes that the overall impacts of this alternative would be MODERATE to LARGE.

- **Water Use and Quality**

For coal-fired operations at an alternate site, impacts to surface waters would result from withdrawal of water for various operating needs of the facility. These operating needs would include cooling tower makeup and possibly auxiliary cooling for equipment and potable water requirements. Discharges to surface water could result from cooling tower blowdown, coal pile runoff, and runoff from coal ash and scrubber byproduct disposal areas. Both the use of surface waters and discharges to surface waters would be regulated by the State within which the coal-fired facility is located.

The NRC staff expects that any new coal-fired facility would comply with requirements of the discharge permits issued for its operation. Thus, the utility would be obligated to ensure that discharges from the plant conform to applicable water quality standards. Water withdrawals from a small river or cooling pond, however, could lead to potential water use conflicts. Overall, the NRC staff concludes that the potential impacts to surface water resources and water quality would be SMALL to MODERATE for a new coal-fired facility located at an alternate site.

Potential impacts to ground water quality at an alternate site may occur as a result of seepage to ground water from coal storage areas and onsite ash and scrubber sludge disposal areas. A coal-fired plant of this size is unlikely to use ground water for cooling tower makeup, however. In all cases, the NRC staff expects that a coal-fired facility would comply with a ground water use and discharge permit issued by the State having jurisdiction over the plant. Complying with permit requirements should ensure a small impact. Therefore, the NRC staff concludes that the potential impacts to water resources would be SMALL to MODERATE.

- **Air Quality**

A coal-fired power plant emits a variety of airborne emissions, including SO_x, NO_x, particulate matter, CO, hazardous air pollutants (HAPs) (e.g., mercury), and naturally occurring radioactive materials.

A coal-fired alternative built in a nonattainment area (such as exists at the current IP2 and IP3 site) would require a nonattainment area permit and a Title V operating permit under the CAA. A new power plant would also be subject to the new source performance standards for such units in Subpart DA, "Standards of Performance for Electric Utility Steam Generating Units for Which Construction Is Commenced after September 18, 1978," of 40 CFR Part 60, "Standards

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of Performance for New Stationary Sources." These regulations establish emission limits for particulates, opacity, sulfur dioxide (SO_2), and NO_x. EPA has various regulatory requirements for visibility protection in Subpart P, "Protection of Visibility," of 40 CFR Part 51, "Requirements for Preparation, Adoption, and Submittal of Implementation Plans," including a specific requirement for review of any new major stationary source in an area designated attainment or unclassified under the CAA.

NRC discussions of SO_x and NO_x emissions include the most recent relevant regulations, because the Clean Air Interstate Rule (CAIR) was vacated by the D.C. Circuit Court in July of 2008. On September 24, 2008, EPA filed for a rehearing of the D.C. Circuit Court decision. Until EPA, Congress, or the courts act, elements of future SO_x and NO_x regulatory approaches remain uncertain.

Emissions of specific pollutants from coal-fired alternatives are as follows:

Sulfur oxides emissions. The NRC staff calculates that a new coal-fired power plant would emit 5236 MT/yr (5754 tons/yr) of SO_x after limestone-based scrubbers remove approximately 99 percent of sulfur compounds from plant exhaust. This plant would be subject to the requirements in Title IV of the CAA. Title IV was enacted to reduce emissions of SO_x and NO_x, the two principal precursors of acid rain, by restricting emissions of these pollutants from power plants. Title IV caps aggregate annual power plant SO_x emissions and imposes controls on SO_x emissions through a system of marketable allowances. EPA issues one allowance for each ton of SO_x that a unit is allowed to emit.

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New units do not receive allowances but are required to have allowances to cover their SO_x emissions. Owners of new units must, therefore, acquire allowances from owners of other power plants or reduce SO_x emissions at other power plants they own. Allowances can be banked for use in future years. Thus, a new coal-fired power plant would not add to net regional SO_x emissions, although it might contribute to the local SO_x burden.

Nitrogen oxides emissions. Title IV of the CAA directed EPA to establish technology-based emission limitations for NO_x emissions (see Section 407), rather than a market-based allowance system as is used for SO_x emissions. A new coal-fired power plant would be subject to the new source performance standards for such plants in 40 CFR 60.44a(d)(1). That regulation, issued September 16, 1998 (Volume 63, page 49453 of the *Federal Register* (63 FR 49453)), limits the discharge of any gases that contain nitrogen oxides (expressed as nitrogen dioxide (NO_2)) to 200 nanograms per joule of gross energy output (1.6 pound/megawatt-hour (MW(h)), based on a 30-day rolling average.

As previously discussed, IP2 and IP3 are located within the New Jersey-New York-Connecticut Interstate Air Quality Control Region (40 CFR 81.13). All of the States of New Jersey and Connecticut, as well as several counties in Central and Southeastern New York within a 80-km (50-mi) radius of IP2 and IP3, are designated as nonattainment areas for ozone (8-hour standard) (EPA 2008b). Operators or owners of a coal-fired power plant constructed in a nonattainment area would need to purchase offsets for ozone precursor emissions. In this case, NO_x is the major ozone precursor emitted by a coal-fired power plant. In accordance with NYSDEC regulations, "Emission offsets must exceed the net increase in annual actual emissions from the air contamination source project" (NYSDEC, Chapter 3, Parts 231–15). By design, this regulatory requirement should result in a net reduction in ozone emissions in the region.

This new coal-fired plant would likely use a variety of NO_x control technologies, including low-NO_x burners, overfire air, and selective catalytic reduction. EPA notes that when these emissions controls are used in concert, they can reduce NO_x emissions by up to 95 percent (EPA 1998), for total annual emissions of approximately 1230 MT/yr (1352 tons/yr) or 0.14 pounds/MW(h). This is significantly less than the amount allowed by Title IV of the CAA.

Particulate emissions. The NRC staff estimates that the total annual stack emissions would include 175 MT (192 tons) of total suspended particulates and 40 MT (44 tons) of particulate matter having an aerodynamic diameter less than or equal to 10 μm (PM_{10}) (40 CFR 50.6, "National Primary and Secondary Ambient Air Quality Standards for PM_{10}"). Some of this PM_{10} would also be classified as primary $PM_{2.5}$.

As indicated in the IP2 and IP3 ER, fabric filters or electrostatic precipitators would be used for particulate control. EPA notes that filters or precipitators are each capable of removing more than 99 percent of particulate matter, and that SO_2 scrubbers further reduce particulate matter emissions (EPA 1998). In addition to flue emissions, coal-handling equipment would introduce fugitive particulate emissions from coal piles, reclamation equipment, conveyors, and other sources.

Fugitive dust also would be generated during the construction of a coal-fired plant, and construction vehicles and motorized equipment would further contribute to construction-phase air emissions. These emissions would be short lived and intermittent, and construction crews would likely mitigate some impacts through dust control measures.

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Carbon monoxide emissions. The NRC staff estimates that the total CO emissions from coal combustion would be approximately 1230 MT/yr (1352 tons/yr) based on EPA-calculated emissions factors for coal-fired power plants.

Hazardous air pollutants including mercury. Following the D.C. Circuit Court's February 8, 2008, ruling that vacated its Clean Air Mercury Rule (CAMR), EPA is working to evaluate how the court's ruling will affect mercury regulation (EPA 2008d). Before CAMR, EPA determined that coal- and oil-fired electric utility steam-generating units are significant emitters of HAPs (EPA 2000a). EPA determined that coal plants emit arsenic, beryllium, cadmium, chromium, dioxins, hydrogen chloride, hydrogen fluoride, lead, manganese, and mercury (EPA 2000a). EPA concluded that mercury is the HAP of greatest concern and that (1) a link exists between coal combustion and mercury emissions, (2) electric utility steam-generating units are the largest domestic source of mercury emissions, and (3) certain segments of the U.S population (e.g., the developing fetus and subsistence fish-eating populations) are believed to be at potential risk of adverse health effects resulting from mercury exposures caused by the consumption of contaminated fish (EPA 2000a). In light of the recent court decision, EPA will revisit mercury regulation, although it is possible that the agency will continue to regulate mercury as a HAP, thus requiring the use of best available control technology to prevent its release to the environment.

Uranium and thorium. Coal contains uranium and thorium, among other naturally occurring elements. According to Alex Gabbard of Oak Ridge National Laboratory, uranium concentrations are generally in the range of 1 to 10 parts per million (ppm), and thorium concentrations are generally about 2.5 times this level (Gabbard 1993). The U.S. Geological Survey (USGS) indicates that Western and Illinois Basin coals contain uranium and thorium at roughly equal concentrations, mostly between 1 and 4 ppm, but also indicates that some coals may contain concentrations of both elements as high as 20 ppm (USGS 1997). Gabbard indicates that a 1000-MW(e) coal-fired plant could release roughly 4.7 MT (5.2 tons) of uranium and 11.6 MT (12.8 tons) of thorium to the atmosphere each year (1993).

Both USGS and Gabbard, however, indicate that almost all of the uranium, thorium, and most decay products remain in solid coal wastes, especially in the fine glass spheres that constitute much of coal's fly ash. Modern emissions controls, such as those included for this coal-fired alternative, allow for recovery of greater than 99 percent of these solid wastes (EPA 1998), thus retaining most of coal's radioactive elements in solid form rather than releasing it to the atmosphere. Even after concentration in coal waste, the level of radioactive elements remains relatively low—typically 10 to 100 ppm—and consistent with levels found in naturally occurring granite rocks, shales, and phosphate rocks (USGS 1997). The levels of uranium and thorium contained in coal wastes and discharged to the environment exceed the levels of uranium and thorium released to the environment by IP2 and IP3.

Carbon dioxide: A coal-fired plant would have unregulated CO_2 emissions that could contribute to global warming. Under the current regulatory framework, a coal-fired plant would have unregulated CO_2 emissions during operations as well as during coal mining and processing, and coal and lime transportation. Burning bituminous coal in the United States emits roughly 93.3 kg (205.3 pounds) of CO_2 per million BTU (DOE/EIA 2008a). The four-unit 2200-MW(e) supercritical coal-fired plant would emit approximately 13.1 million MT (14.5 million tons) of CO_2 per year assuming a heat rate of 8661 BTU/kWh (DOE/EIA 2007b). Section 6.2 of this draft SEIS contains a discussion of current and likely future relative GHG emissions from several

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energy alternatives, including coal, natural gas, nuclear, and renewables. In Section 6.2, the NRC staff found that GHG emissions from coal would likely exceed those from other energy alternatives throughout the period of extended operation.

Visibility Regulations: Section 169A of the CAA (42 USC 7491) establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory Class I Federal areas when impairment results from manmade air pollution. EPA issued a new regional haze rule in 1999 (64 FR 35714). The rule specifies that for each mandatory Class I Federal area located within a State, the State must establish goals that provide for reasonable progress towards achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility for the most-impaired days over the period of the implementation plan and ensure no degradation in visibility for the least-impaired days over the same period (40 CFR 51.308(d)(1)). If a coal-fired alternative were located close to a mandatory Class I area, additional air pollution control requirements would be imposed. New York has no Class I areas; of the neighboring States, New Jersey and Vermont each have one—the Brigantine Wilderness Area and the Lye Brook Wilderness, respectively. Brigantine is located about 225 km (140 mi) south of IP2 and IP3, while Lye Brook is roughly 215 km (135 mi) north-northeast. A coal-fired alternative located near these areas or any other Class I area may need additional pollution controls to keep from impairing visibility.

Summary. The GEIS analysis did not quantify emissions from coal-fired power plants, but implied that air impacts would be substantial. The GEIS also mentioned global warming from unregulated CO_2 emissions and acid rain from SO_x and NO_x emissions as potential impacts (NRC 1996). The NRC staff's analysis shows that emissions of air pollutants, including SO_x, NO_x, and CO, would be significant and would be greater than all other alternatives. Operational emissions of CO_2 are also greater under the coal-fired alternative than under any other alternative.

The NRC analysis for a coal-fired alternative at an alternative site indicates that impacts from the coal-fired alternative would have clearly noticeable effects, but given existing regulatory regimes, permit requirements, and emissions controls, the coal-fired alternative would not destabilize air quality. Thus, the appropriate characterization of air impacts from coal-fired generation would be MODERATE.

- **Waste**

A four-unit, 2220-MW(e) coal-fired plant with a heat rate of 8661 BTU/kWh (DOE/EIA 2007b) would annually consume approximately 5.4 million tons of coal having an ash content of 7.11 percent (Entergy 2007). After combustion, 99.9 percent of this ash, approximately 345,800 MT (380,000 tons) per year, would be collected and disposed of at either an onsite or offsite landfill, or recycled. Based on industry-average recycling rates, approximately 155,610 MT (171,000 tons), or 45 percent, of the ash content would be recycled, leaving a total of approximately 190,190 MT (209,000 tons) for disposal (ACAA 2007). In addition, approximately 300,300 MT (330,000 tons) of scrubber waste would be disposed of or recycled each year. Based on industry-average recycling rates, approximately 237,000 MT (260,700 tons), or 79 percent, of gypsum scrubber waste would be recycled (ACAA 2007). As mentioned in the Air Quality section, this waste also would contain levels of uranium and thorium in concentrations similar to those found in naturally occurring granites, shales, and phosphate rocks (USGS 1997). In addition to coal combustion wastes, a supercritical coal-fired alternative

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also would produce small amounts of domestic and hazardous wastes.

Disposal of the waste could noticeably affect land use and ground water quality, but with appropriate management and monitoring, it would not destabilize any resources. After closure of the waste site and revegetation, the land could be available for other uses.

In May 2000, EPA issued a "Notice of Regulatory Determination on Wastes from the Combustion of Fossil Fuels" (EPA 2000b). EPA concluded that some form of national regulation is warranted to address coal combustion waste products because (1) the composition of these wastes could present danger to human health and the environment under certain conditions, (2) EPA has identified 11 documented cases of proven damages to human health and the environment by improper management of these wastes in landfills and surface impoundments, (3) disposal practices are such that, in 1995, these wastes were being managed in 40 to 70 percent of landfills and surface impoundments without reasonable controls in place, particularly in the area of ground water monitoring, and (4) EPA identified gaps in State oversight of coal combustion wastes. Accordingly, EPA announced its intention to issue regulations for disposal of coal combustion waste under Subtitle D of the Resource Conservation and Recovery Act (RCRA). EPA has not yet issued these regulations.

In addition to the waste streams generated during plant operations, considerable debris would be generated during construction of a coal-fired facility. Crews would likely dispose of land-clearing debris on site.

For all of the preceding reasons, the NRC staff considers the impacts of managing waste generated by a coal facility (construction and operating phases) to be MODERATE—the impacts would be clearly noticeable, but would likely not destabilize any important resource.

- **Human Health**

Coal-fired power generation introduces risks to workers at many points in the fuel cycle. These risks include risks from mining coal and limestone, transportation of raw materials, plant construction and operation, and waste management. There also may be public health risks from a coal-fired plant's operation (routine emissions and coal-pile fires) and fuel cycle (mining and transportation).

During construction activities there would be risk to workers from typical industrial incidents and accidents. Accidental injuries are not uncommon in the construction industry and accidents resulting in fatalities do occur. However, the occurrence of such events is mitigated by the use of proper industrial hygiene practices, complying with worker safety requirements, and training. Occupational and public health impacts during construction are expected to be controlled by continued application of accepted industrial hygiene protocols, occupational health and safety controls, and radiation protection practices.

In the GEIS, the NRC staff stated that human health impacts (cancer and emphysema) could arise from chronic exposures to coal-fired plant emissions. Emissions contain pollutants such as toxins, particulates, and low levels of naturally occurring radioactive elements. However, Federal and/or State agencies regulate these emissions and enforce emissions standards that are designed to be protective of human health. As a result, power plants install appropriate emission controls to meet regulatory standards.

Coal-fired generation would introduce mechanical sources of noise that would be audible off site. Sources contributing to total noise produced by plant operations are both continuous and

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intermittent. Continuous sources include the mechanical equipment associated with normal plant operations. Intermittent sources include the coal-handling equipment, solid-waste disposal systems, outside loudspeakers, and commuting activities of plant employees. Noise impacts associated with rail delivery of coal and lime to the generating station site would be most significant for residents living along the new rail spur leading to the plant. Although passing trains significantly raise noise levels near rail corridors, the short duration of the noise tends to minimize impacts.

Based on the cumulative potential impacts of construction activities, emissions, and noise on human health, the NRC staff considers the impact of constructing and operating a new coal-fired facility to be MODERATE.

- **Socioeconomics**

Construction of a coal-fired facility at an alternate site would take approximately 4 years (DOE/EIA 2007b). Based on estimates given in Table 8.1 of the GEIS, the peak workforce is estimated to range from 1.2 to 2.5 additional workers per MW(e) during the construction period. For the 2200-MW(e) plant utilized in this analysis, the peak workforce would range from approximately 2640 to as many as 5500 workers during the 4-year construction period (NRC 1996). During construction, the surrounding communities would experience demands on housing and public services unless some of the workforce is composed of local residents. In the GEIS, the NRC staff stated that socioeconomic impacts would depend on the location of the new plant. For example, at a rural site more of the peak construction workforce would need to relocate (temporarily or permanently) to the area to work. Therefore, socioeconomic impacts could range from SMALL to LARGE depending on whether workers would relocate to be near the site, as well as depending on the size and makeup of the existing community.

At the end of construction, the local population would be affected by the loss of as many as 5000 construction jobs. However, this loss would be partially offset by a postconstruction permanent employment rate of 0.25 workers per MW(e) based on Table 8.2 of the GEIS, or a total of 550 total workers. An additional construction workforce would be needed for the decommissioning of IP2 and IP3 which could temporarily offset the impacts of the lost construction and IP2 and IP3 jobs at the site.

The coal-fired plant would provide new tax revenue to its community. Because this plant would be located in another community, it would have a positive impact on its community while the shutdown of IP2 and IP3 will have a negative impact on the tax base of the IP2 and IP3 community.

The NRC staff concludes that the overall socioeconomic impacts of changes in the local population from the influx of the construction workforce and changes to community tax revenues could be SMALL to LARGE during construction and SMALL to MODERATE during operation, depending on the size and economic structure of the affected communities.

- **Transportation**

During the 4-year construction period of the coal-fired unit, as many as 2600 to 5500 construction workers may be working at the site. During this same time period, trucks and trains would likely be delivering construction materials to the site. The addition of these workers would increase traffic on highways and local roads that lead to the construction site. The impact of this additional traffic could have a MODERATE to LARGE impact on nearby roadways, particularly if

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the alternate site is in a rural area. Impacts associated with plant operating personnel commuting to work are likely to be SMALL.

For rail transportation of coal and limestone to the alternate site, impacts are likely to range from SMALL to LARGE, depending on local rail characteristics. On average, more than ten 100-car trains per week would deliver coal to the new generating station, and two 10-car trains per week would deliver limestone to the facility. Transportation impacts associated with coal and limestone delivery could range from SMALL to LARGE

Overall, transportation impacts could range from MODERATE to LARGE during construction, and SMALL to LARGE during operation.

- **Aesthetics**

At an alternate site, plant buildings, exhaust stacks, cooling towers, and cooling tower plumes would create aesthetic impacts. The coal-fired alternative's four power plant units would be up to 200 ft (61 m) tall and may be visible off site in daylight hours. The three exhaust stacks could be up to 600 ft (183 m) high (at least 500 ft (152 m) for good engineering practice). If the coal-fired alternative makes use of natural-draft cooling towers, then additional visual impacts will occur from the towers, which may be several hundred feet tall and topped with condensate plumes. Mechanical-draft towers would also generate condensate plumes, but would be markedly shorter than natural-draft towers (or they may use hybrid towers like the alternative described in Section 8.1 of this draft SEIS). Other buildings on site may also affect aesthetics, as could construction of new transmission lines. Noise and light from plant operations, as well as lighting on plant structures, may be detectable off site.

Aesthetic impacts at the plant site would be minimized if the plant were located in an industrial area adjacent to other power plants or industrial facilities. Development of a new coal-fired facility at an undeveloped alternate site, however, would entail construction of a new transmission line and a new rail spur to bring coal and lime to the plant. The rail spur and transmission line could extend many miles from the site to tie-in points with existing rail and transmission systems. The visual intrusion of these two linear elements, particularly the transmission line, could be significant.

Overall the aesthetic impacts associated with locating at an alternate site would be categorized as MODERATE to LARGE for an undeveloped site, and may be SMALL to MODERATE at a site previously developed for industrial uses.

- **Historic and Archeological Resources**

A cultural resource inventory would be needed for any property that has not been previously surveyed. The survey would include an inventory of field cultural resources, identification and recording of existing historic and archeological resources, and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site. The studies would likely be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission corridors, rail lines, or other ROWs).

Historic and archeological resource impacts can generally be effectively managed and, as such, would be considered SMALL to MODERATE at a new undeveloped site, depending on the sensitivity of the site. For a previously developed site, most of which have already been

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intensively developed, impact on cultural and historic resources would also be SMALL. Previous development would likely have either removed items of archeological interest or may have included a survey for sensitive resources. Any significant resources identified would have to be handled in accordance with the NHPA.

- **Environmental Justice**

As described in Section 8.2 of this draft SEIS, no environmental impacts were identified that would result in disproportionately high and adverse environmental impacts on minority and low-income populations if IP2 and IP3 were shut down.

Impacts at the location of the new four-unit coal-fired plant would depend upon the site chosen and the nearby population distribution, but would likely be SMALL to MODERATE for most alternate sites, but could reach LARGE. For previously developed industrial sites, impacts could be larger or smaller, depending on the relative proximity of low-income populations.

Table 8-3. Summary of Environmental Impacts of the Coal-Fired Plant Alternative Located at an Alternate Site

Impact Category	Impact	Comment
Land Use	MODERATE to LARGE	Uses up to 1500 ha (3700 ac) for plant, offices, parking, and waste disposal; additional impacts from transmission line and rail spur, as well as coal and limestone mining.
Ecology	MODERATE to LARGE	Impacts to terrestrial ecology would likely be MODERATE to LARGE, while impacts to aquatic ecology would likely be SMALL.

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Table 8-3 (continued)

Impact Category	Impact	Comment
Water Use and Quality	SMALL to MODERATE	With closed-cycle cooling, the impact would likely be SMALL, though it would depend on the volume of water withdrawn and discharged and the characteristics of the surface water body.
Air Quality	MODERATE	• SO_x: 5230 MT/yr (5748 tons/yr) • NO_x: 1129 MT/yr (1351 tons/yr) • Total suspended particulates: 175 MT/yr (192 tons/yr) • PM_{10}: 40 MT/yr (44 tons/yr) • CO: 1129 MT/yr (1315 tons/yr) • Small amounts of mercury and other hazardous air pollutants Extensive emissions controls and regulations limit impacts to MODERATE.
Waste	MODERATE	Total waste production would be approximately 645,000 MT/yr (710,000 tons/yr) of ash (after some is recycled) and scrubber sludge requiring approximately 150 ha (370 ac) for disposal during the 40-year life of the plant. The plant would also generate relatively small amounts of conventional, hazardous, and universal wastes during operation.
Human Health	MODERATE	Impacts are uncertain, but considered MODERATE as the plant would comply with health-informed standards in the CAA and other relevant emissions regulations. Minor risk to workers associated with construction and industrial accidents.
Socioeconomics	SMALL to LARGE	Construction impacts depend on location, but would be LARGE if the plant is located in an area that is rural or is growing less quickly than areas near IP2 and IP3. IP2 and IP3 communities may lose tax revenue and employment, though economic growth would likely offset much of this loss. Impacts from placement of a plant near to an urban area may be MODERATE. Impacts during operation would be smaller than during construction.
Transportation	MODERATE to LARGE	Transportation impacts could be MODERATE to LARGE, during construction, though operational impacts may be smaller during operations.
Aesthetics	SMALL to LARGE	The greatest impacts would be from new transmission lines, plant stacks, and rail lines to transport coal and lime. Impacts would be largest at an undeveloped site.

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